THE
ENGINEERING MAGAZINE
VOL. XVI. FEBRUARY, 1899. No. 5.

READINGS FROM EXPERIENCE IN NAVAL ENGINEERING.

By Engineer-in-Chief George W. Melville, U. S. N.

THE great successes of the United States navy in the recent war with Spain, notably the remarkable victories at Manila and Santiago, have aroused the pride of the people in the navy to a point which it had never reached before, so that they have been studying with considerable interest the elements which have contributed to that success. This has called attention to the fact, which has been pointed out repeatedly, that the war which has just ended might appropriately be called, as respects the navy, an engineer's war, using the term "engineer" in the broad sense, which includes the designers and manufacturers as well as the manipulators of the great fighting machine which the modern war-ship has become. It is eminently fitting, therefore, that the story of the war should include very prominently the part played therein by machinery, wherefore I am to treat here of the importance of steam engineering in naval warfare, and especially in the recent American victories.

When the steam engine first received a place in naval vessels, there was probably little idea that it would ever play the important part which it does now, as the machinery was considered, and actually was, auxiliary to sail power. The sole purpose of its installation upon the war-ship was to give facility in getting in and out of port and in manœuvring against unfavorable winds or in a calm. The highest speed was attained under sail, and the "weather gauge" in battle still depended largely upon the skill in handling sails. There was a good reason for this, the machinery being enormously heavy for the power developed, and consuming so much fuel that it was impossible to carry coal enough to move machinery of full power for even a few days. Nevertheless, the first step had been taken, and, as we now know, the problem was to increase economy and reduce weight.

Copyright, 1898, by John R. Dunlap.

During the civil war in the United States, the country was fortunate to have, at the head of the engineering department of the navy, Commodore Isherwood, one of the most famous engineers which the country has produced, and a man who has made the whole profession of steam engineering his debtor. Assuming control at a time when the paddle-wheel engine was still largely used on war-vessels, the close of his administration saw the complete substitution of the screw-propeller. During his term of office the factors which limited large powers for machinery of war-ships were still controlling, as steam pressures and rates of rotation were still low, and the materials at the disposal of the designer were much inferior to those now available. Further than this, practically all the vessels were built of wood, and the engines were horizontal, so that rapid rates of reciprocation were inadmissible. Still another item has to be taken into account,—the fact that the United States navy was suddenly expanded to an enormous extent, necessitating the care of the machinery by a personnel the greater portion of which was untrained, and some portion of which was almost incompetent. It was necessary, therefore, that the machinery should be made heavier than sound designing would have dictated where proper care could have been assured. It must be remembered that, while light and economical machinery is, under normal conditions, the object to be attained, the purpose of a war vessel is to move with certainty, and Isherwood properly considered that, however perfect designs might be from the standpoint of the professor, the country would consider them failures if they broke down.

While considering the machinery of the civil war period, we must note the wonderful performance of the vessel which was Isherwood's greatest triumph, the Wampanoag. She was only one of a class designed with the special object of producing the fastest steamers in the world. She and the Ammonusuc were the only vessels of Isherwood's design which were tried, and both completely fulfilled expectations. The Wampanoag made a trial trip at sea in comparatively rough weather, lasting for thirty-eight hours, and for the whole trip averaged 16.6 knots. During several six-hour periods she averaged 17 knots, and the maximum speed was 17.75 knots. When it is remembered that she was designed about 1865 and tried in 1868, this performance is seen to excel anything in the history of marine engineering, for at that time the fastest vessels, either in the merchant marine or in the navy, did not make more than 13 knots. In fact, so great was this speed that it was not reached again in war vessels for more than a decade. Owing to the wooden hulls in which the machinery was to be placed, Isherwood adopted a type of engine which he, better than any one else, knew to be very heavy, but it enabled

him with safety to put great power into the limber hull, and secured the result at which he aimed. The machinery of the Wampanoag consisted of two cylinders one hundred inches in diameter by forty-eight inches' stroke and running at thirty-one revolutions per minute for full power. The crank shaft was so geared to the propeller shaft as to give the latter sixty-three revolutions per minute. The horse power was slightly in excess of four thousand, and the steam pressure carried thirty-two pounds. The boilers were of the Martin vertical water-tube variety, and superheating boilers, in addition to the main boilers, were used, so that the expenditure of coal per horse power was 3.15 pounds—an economical figure for that day. The total weight of the machinery and water was 1,250 tons, or 3.24 i. h. p. per ton.

Shortly after the close of Mr. Isherwood's term of office, the compound engine was introduced into the United States navy, working at first with a steam pressure of about eighty pounds. Most of the vessels so fitted were small, and consequently high speeds were not attempted, the vessels of the Vandalia class, which were in their day very useful, having a speed of 12 knots with a displacement of about 2,000 tons. These were followed by the Trenton, which had a three-cylinder compound engine, but in which there was still no improvement in the weight of machinery per unit of power. From 1875 to 1883 there was a period of almost entire stagnation in the United States navy, work being confined almost exclusively to repairs, but then came the period of the advisory board and the vessels commonly known as the Roach cruisers. In these the pressures were increased to ninety and one hundred pounds, but there was still a very great weight per unit of power, none of these vessels being designed on the principle of high rotational speeds, introduced at about that period.

The vessel which really brought about the revolution in respect to speeds of rotation was the Esmeralda, of the Chilean navy, built by the Armstrongs in England in 1883; she for the first time surpassed the record of the Wampanoag, making a trial-trip record of more than 18 knots, although, as she was never run at full power for any long period, like the Wampanoag, it may be doubted whether she could have equaled that vessel's record for a period of the same length. The Esmeralda, besides having fast-running engines, also used forced draft, which, within a few years preceding her trial, had gradually been re-introduced for fast vessels. The term "re-introduced" is used, because forced draft is really the invention of an American engineer, Mr. Edwin A. Stevens, and, as was pointed out by Mr. James Howden in 1893, Mr. Stevens practically used every form of forced draft with which we are now acquainted.

During the period since the introduction of the compound engine

steam pressures had gradually been rising, making it possible to use a greater range of expansion, so that by this time the weight of machinery had been reduced and its economy increased, thereby justifying the use of large powers, especially as the use of wood as a hull material had been entirely abandoned, and the iron and steel hulls gave an amply strong foundation for the machinery used.

The next great step in advance was not long in coming,—namely, the introduction of the multiple-expansion engine by Dr. A. C. Kirk, of Glasgow. The first successful use of the triple-expansion engine was on the steamer Aberdeen in the merchant service, but very soon afterward Dr. Kirk proposed to the British admiralty to install triple-expansion engines in two vessels that he was building for them, designed originally for compound engines. The permission being granted, these vessels, the Australia and Galatea, ran successful trials in 1887, and since that time very few war vessels have been built with expansion at fewer than three stages.

We have now reached the point when the new United States navy began, and when several principles of correct design had been thoroughly established,—namely, high steam pressures, rapid rotation, forced draft for boilers, and a rigid inspection of material, making the scantlings a matter of close calculation, instead of a sort of refined guesswork disguised under the formula of large factors of safety.

It must be understood that many of the factors of improved design were so related that some were a natural consequence of others; this is notably the case with the improvement in material at the disposal of the designer. When it seemed that the limit had about been reached with wrought iron as the main reliance of the designer, mild steel had been so perfected as to enable progress to be maintained. The large boilers necessary to withstand the high pressures and furnish the power for high speeds would have been impossible but for mild steel, and the same thing is true of the moving parts of the engine. It may be noted also that workmanship had improved, and the use of anti-friction metals, combined with this improved workmanship, enabled the high speeds to be carried out with safety and reliability.

It has already been stated that the Wampanoag's machinery was so heavy that only 3.24 i. h. p. per ton of machinery was obtained. The San Francisco, one of the earliest of the modern cruisers of the United States navy in which advantage was taken of all the factors for reduction of weight, obtained 10.63 i. h. p. per ton of machinery.

It seemed for a time that further reduction of weight must depend upon the boilers, and, as forced draft furnished a ready means of burning any desired amount of coal, the designers who wished to be considered most progressive attempted to get a greater amount of

power from a given amount of heating surface in the boiler. This, however, was not attended with success, and the experience of the British navy for a time was peculiarly unfortunate. In the United States navy, where the officials attempted to be progressive, while at the same time not being too radical, no attempt has ever been made to get a horse power from less than two square feet of heating surface. In some of the British vessels this figure was carried below one and one-half square feet, with the result that trial after trial was a failure, due to leaky tubes, and it was only after the adoption of what is known as the "Admiralty Ferrule" that the trials could be carried out even at reduced power.

There had been for many years a gradual increase in the size of ships, and with this increase of size there was an application of the law commonly known by the name of "Froude," although first announced by Reech, which in popular language may be expressed by saying that, for economy, big speeds belong to big ships. This fact is somewhat masked to the popular mind by the torpedo boats,—which are the fastest war vessels, although the smallest,—but a comparison of the Minneapolis, which made 23 knots, with the little Cushing, which made 22½, will show the difference in economy of power compared with displacement.

In the Minneapolis the speed of 23 knots was obtained with an expenditure of 2.84 i. h. p. per ton of displacement, while in the Cushing the corresponding figure is 16.7 i. h. p. The San Francisco class in the United States navy, which comprises four vessels, is of about 4,500 tons' displacement,—slightly larger than the Trenton, with an increase in speed of more than five knots. The Minneapolis and Columbia, of about 7,500 tons' displacement, were appropriately made faster vessels, the former making 22.8 and the latter 23.7 knots on their trials.

This question of speed is a vital one for the engineer, as it is the constant incentive to invention and improvement in design for the purpose of constantly reducing the weight per unit of power. Since vessels have become wholly dependent upon machinery for their propulsion, the "weather gauge" has become the highest sustained speed, and consequently the officers who are to command the ships are steadily demanding the highest speeds. This has led designers in every country to resort to every means to secure this end.

The growth of the factor which has caused the latest revolution in marine engineering—namely, the use of the water-tube boiler—has been very rapid in recent years. Water-tube boilers in some form are very old, not only on land, but at sea. Their use for large powers, however, is of recent date, and the United States may claim the earli-

est use of a large amount of power in water-tube boilers at sea—in the coast-defence vessel, the Monterey, in which such boilers, built by Mr. Charles Ward, for 4,800 i. h. p., were installed in 1891.

Boilers of this type had been used in the French navy for some years before this, but not for very large powers. For torpedo boats water-tube boilers had for some time been extensively used, and not very long afterward they entirely displaced the locomotive type. In France water-tube boilers of various types have entirely displaced the cylindrical boiler within the last few years, and the same is true of the English navy.

In the United States navy, after the installation on the Monterey, little was done until recently towards extending their use on ships of any size, and I trust I may be pardoned for a brief word of explanation in this connection, as my position in the matter may not have been thoroughly understood. The merits of the water-tube boiler have been so thoroughly set forth in this magazine and elsewhere that I need say only that, when these boilers were placed in the Monterey, I was fully aware of their advantages, but in the building of the navy the United States were in a different position from that of other countries. England and France, which were introducing the water-tube boiler so rapidly for large vessels, were adding to powerful fleets already in existence. The United States were building battle-ships for the first time, and I felt that, with all its advantages, there were certain disadvantages of the water-tube boiler which made it undesirable to adopt anything of an experimental nature in these few battle-ships, until the unqualified success of the new type of boiler had been demonstrated. In my annual report of last year to the secretary of the navy, I stated that, in my judgment, the time had arrived when it was perfectly safe to use water-tube boilers exclusively in all classes of vessels. At that time, besides the Monterey and all the torpedo boats, water-tube boilers were in use on the Nashville, Marietta, and Annapolis, and were being installed on the Chicago and Atlanta. Since that time all the designs from the bureau of steam engineering have been for water-tube boilers, and I consider that for war vessels the cylindrical boiler is now as definitely abandoned as the compound engine.

A word in passing may be given to some of the special advantages which water-tube boilers present for naval purposes. One is the great tactical advantage, which was very thoroughly brought out by the conditions of the blockade at Santiago,—namely, the quickness with which steam may safely be raised. In large cylindrical boilers steam can be raised from cold water in about three hours, but this is almost sure to injure the boilers by the unequal expansion. In water-tube boilers steam can be raised with perfect safety in half an hour or

less, depending upon the size and type. To maintain vessels in readiness for instant use with cylindrical boilers fires must be kept in all the boilers, involving a large expenditure of coal, which in some of the ships on the Santiago blockade amounted to as much as thirty-five tons per day. With water-tube boilers this would not be necessary; a much smaller coal expenditure would suffice.

Another great advantage of water-tube boilers is the facility with which extensive repairs can be carried out without serious disturbance to the hull of the vessel. The Monterey's boilers were practically rebuilt a little more than a year ago by the force on board, without any change in the structure of the ship whatever. The most notable instance, however, occurred last summer, when three of the old monitors built during the war of '61-'65 had their old box boilers cut up and removed and new water-tube boilers installed. The pieces of the old boilers were passed out, and the parts of the new boilers were passed in through the smoke-pipe opening and assembled in place. Had any other than a water-tube boiler been put in, it would have been necessary to take up the whole deck over the boilers, and thus greatly delay the entrance of the vessel into service, whereas the water-tube boilers were in place and ready for steam in about thirty days after the contract for their building was placed.

The use of twin screws in naval vessels has been the rule so long that we are sometimes inclined to forget that it was not always so, and that this arrangement was a marked step in advance from a tactical standpoint, besides furnishing greater security against disablement.

A further step has been made in the use of triple screws on many vessels, the most notable of the early cases being the Columbia and the Minneapolis. The use of multiple screws dates back a considerable period, for what were known as the "tin clads" on the Mississippi during the United States civil war had four screws. The French were really the first to use triple screws for a large vessel, which they decided upon as a result of careful experiments on a steam launch. Before the Dupuy de Lome had been launched, when it was arranged to build for the United States two commerce destroyers, or "pirates," as they were familiarly called for a long time, it was decided to use three screws for constructive reasons, and with the idea that, for ordinary cruising, it would be more economical to run with a single screw than with two, on account of the fact that cruising power for one engine of three would form a larger percentage of its maximum power than it would in the case of each of the larger engines of twin screws.

When the Columbia and Minneapolis were tried, it was found, to the great astonishment of everybody, that apparently their economical performance was higher than that with twin screws. The determination

of the speed was beyond question, and the accuracy of the power measurement was thoroughly verified, so that, whether the economy was due to the use of three screws or not, it is undoubtedly a fact that these two vessels showed a smaller horse power per ton of displacement at their maximum speeds than that shown by similar vessels with twin screws. That this economy is due to triple screws has been disputed, and it is claimed that tank experiments in England have demonstrated that there is no economy in the use of three screws rather than twins; as a result, in the English navy no vessels have been built with triple screws. Exactly the opposite of this is true in France, Germany, and Russia, where nearly all the recent vessels of large power (more than thirty in number) have been built with triple screws, and it is probable that in the next lot of vessels the United States will adopt the same plan.

The results at Santiago showed that three screws have a tactical advantage over the other method, combining economy and great power where two sets of engines are placed on each shaft. The New York and Brooklyn are each fitted in this way, and on the day of the battle each was cruising with her forward engines uncoupled. There was not time to stop for coupling up the forward engines, which, moreover, were not warmed up and ready for use, and, as a result, the vessels could work only at half power. Had they been fitted with triple screws, the engines not in use could have been started as soon as they were warmed up, and thus full power would have been attained in a short time, even had all the engines not been in readiness at the moment of the sortie.

It may be remarked in this connection that triple screws would have many advantages for the high-speed merchant steamers now becoming common. The great advantage possessed by twin screws in the security against total disablement would be emphasized in the case of triple screws, as the breaking of the shaft would reduce the power only one-third instead of one-half. There would also be the great benefit of a reduction in the size of parts, as the engines now built are very large. It would be the greatest advertisement that any company could have, and would undoubtedly attract passengers. This is shown by the action of a prominent United States senator some years ago, who, after buying a return ticket and finding that it involved traveling on single-screw ships, disposed of it at a considerable loss, that he might go by a twin-screw vessel.

In another paper I shall discuss some of the lessons which were taught by the Spanish-American war, and also some other features of importance in the machinery of modern war vessels.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

II.—LABOR-SAVING MACHINERY AND LOW-WAGE-WORKERS.

THE idea is common on both sides of the Atlantic that American wages are high, and that most articles can be produced by European workmen more cheaply than by American. The common fallacy is to speak of wages as the sum of money received by labor for work covering a certain period of time. In reality wages are that reward which labor receives for a certain product. Wages are high when labor receives a large amount for that product; they are low when it receives a small amount for that product. In this latter sense American wages are the lowest in the world. One of the reasons that Americans are able to produce machine tools at a price which competes with that of the European article is that the wages paid for the same quality of product are less than those paid by the European manufacturer. This statement can be easily verified, and an examination of the conditions under which the machines are produced will show how it is accomplished.

In the production of machine tools, as well as other articles, Americans make use of labor-saving machinery as extensively as possible. As a natural result, a great deal of the labor on their machines is performed by the low-wage-worker. At the same time, the skilled worker earns more in a given time than his European brother. As in the manufacture of other articles, the idea in the production of machine tools, according to American practice, is to "machine" as close as possible to "finish dimensions," with as much accuracy as is attainable, and to allow very little for "fitting" or hand finish. The general European practice is the opposite of this, and it is customary to use machines simply for removing more or less metal,—not for working closely to finished dimensions,—leaving a large amount of work to be done by the so-called fitter. A good example of the latest American practice, in the above respect, is the results accomplished with the aid of the universal grinding machine. It is daily becoming more common to turn cylindrical parts only approximately to finished dimensions, taking little care to produce true or finished surfaces in the lathe. After it is roughed out, the work is put into the grinding machine, and ground truly cylindrical and exact to gauge, whether the part be hardened steel, soft steel, or cast iron. In many cases the workman who finishes the part does not see the piece into which it fits. The old "cut and try" method is largely done away with.

This reduces "fitting" to a minimum, and the result is a higher grade of work than can possibly be produced by the most skilful "turner," or lathe hand. By this system it is possible for the lathe attendant to be a comparatively unskilful operator, and to attend two or three machines taking heavy cuts and using fast feeds. The same is true of grinding work; one attendant can run two or three machines, simply working to limit gauges. As contrasted with these methods, the old way of turning nearly to size, and then filing to a fit, is still followed, with rare exceptions, in European shops. Of course, by the old method, work which is good and at the same time cheap cannot be produced. The system of sub-dividing work is carried so far in many American machine shops that the lathe hand is not allowed even to grind his own turning tools. The practice is rapidly extending of employing special machines for grinding lathe and planer tools. As fast as these tools need re-grinding, they are sharpened by one man,—not by any means a skilled workman, but one whose sole work is keeping tools of this particular class in proper cutting condition. Of course, a certain amount of skilled labor is and always will be necessary, but the practice followed by American machine-tool makers, who are now supplying a high-class article at a reasonable price, is to work, as far as possible, independently of the "craft," and to make use of well-paid tool-makers, who can produce jigs and fixtures by which parts can be cheaply and accurately manufactured.

In the production of cylindrical work, the turret machine is, as a labor-saving machine, now playing an important part,—particularly the flat turret lathe, and others which have been, more or less, inspired by the success of this tool. By the use of this machine, many parts, such as studs, short shafts, spindles, etc., can be produced at one-third or one-fourth the cost of lathe work, and it has been adopted by many manufacturers. As in other cases of labor-saving machinery, the operator is comparatively unskilled, but the machine should be under the control of a well paid tool-maker. It would surprise many makers of machinery to know for how small a number of parts, according to the makers of this machine, it will pay to "set up." The automatic screw machine is also being used to produce machine parts, although not extensively except for the production of screws. However, it is being so rapidly improved that it is sure to be more widely adopted, particularly by those who specialize and make in quantities.

Another interesting comparison of the methods employed, where labor-saving machines are used on the one hand and skilled labor is depended upon on the other, is in the finishing of cylindrical holes of small dimensions. This operation is known to the European manu-

facturer as "boring," and it is usually done either on a lathe of the ordinary type or on what is known as a surfacing and boring lathe. The tools for drilling, boring, and reaming are successively inserted in the same holding device,—either the tool post or the tail stock of the lathe. The operator must set the tools for each part, and must repeat the operation of setting and removing the tools as many times as there are pieces to be bored. This takes time, and calls for skilful manipulation. In American practice every well-regulated machine shop has what is called its "chucking" department. All articles requiring finished holes are sent to this department, which is fitted with machines known as turret-head chucking machines. These machines are arranged with special tools, which operate successively on the parts, the last operation being to finish the hole to size with an adjustable reamer. All work is kept to standard by limit gauges. With this method the tools are not removed from the machine until the required number of parts are "chucked." No time is lost in repeatedly setting up, and no skill is necessary on the part of the operator after the tools are once fixed. His wages average a dollar and a half per day, and he will turn out from two to three times more work than the best lathe hand earning from thirty-eight to forty-five shillings per week,—the average European wages for a good engineer. It will be seen that, in the ordinary machine shop, the bulk of this class of work can be done by low-wage operators. Skilled labor is called for only on the part of the tool-maker or foreman, who can easily keep in order eight or ten machines; his wages average perhaps three dollars per day, but, as they are distributed over a lot of ten machines, they add little to the cost of production. Not only is the work produced cheaper, but it has the usual advantages resulting from the use of labor-saving machinery; it is better work, of uniform quality, and can be done in one third the space which would be occupied if it was done on lathes. The general result is the development of a higher grade of workmanship, which makes interchangeability in machine-tool construction one of the near possibilities; in fact, this is already extensively carried out in the making of smaller machine-tool parts. Progress in one department makes progress possible, even compulsory, in other departments; as, for instance, when all holes are chucked to gauge, it is an easy matter for cylindrical parts to be finished to gauge, reducing fitting work to a minimum. Notwithstanding the fact that the above method offers many advantages, and that it has been in use for some time in American shops, properly-equipped chucking departments are practically unknown in European workshops. There parts which must be turned on an arbor are, as a rule, finished outright by the lathe hand. He first uses his lathe as a bor-

ing machine,—for which it is not adapted. He then, for turning, uses the lathe,—which is very often spoiled in design by attempting to make it useful as a boring machine. After the part is turned, this lathe is converted into a polishing machine; emery dust surely does not add to its value as an accurate tool. This way of working gives variety, but not economy. Neither the machine or the worker can produce its best. Time is lost in constantly changing tools, and skill, which comes only from constant practice, cannot be acquired. Nearly all cylindrical work is included under the four operations, chucking, turning, grinding, and polishing. Machine shops should be so organized that these operations can be performed only in separate departments, by experts who do only one class of work, and on machines best adapted to the end in view.

Another contrast of methods may be observed in the finishing of flat surfaces. The European maker of machine tools has made but little application of the milling machine, and nearly all flat surfaces are reduced on the planer. It is well known that the planing machine requires the highest skill in its manipulation, if anything like accurate surfaces are desirable and expensive "fitting" is to be avoided. Consequently it is important to do away with planing as much as possible. The latest American practice is, in many cases, to rough-mill large surfaces on heavy milling machines, and then to finish these surfaces accurately with a light cut on the planing machine. By this method the removal of metal is accelerated three or four times, and seventy-five per cent. of the work is done by unskilled attendants. Small parts are finished outright on the milling machines, planing being done away with entirely; they are then made perfectly true on the surface grinder, one operator attending two or three machines; and a high finish is attained without any hand labor whatever, whether the material be cast iron, soft steel, or hard steel. With these methods a large part of the work of producing true flat surfaces can be done by low-wage machine attendants who run from two to four machines; the tool-maker is necessary, of course, to keep the machines in order, but, as in other cases, his higher wages are distributed over a group of machines. Of course, the most effective results are realized when this system is carried out on the largest scale,—as with the manufacturers of special lines, who are producing machine tools in limited varieties, but in large quantities. Even in small shops, however, and in those which make large varieties, all the above methods, common to American practice, could be introduced with success into European shops, thereby reducing the costs of manufacture and improving the quality of work.

The general tendency is for American manufacturers to reduce the

great number of workers to low-wage attendants, to elevate a smaller number of skilled workers to a higher position with big wages, and to rely mainly on labor-saving machinery, not on a large number of average workers. The tendency in European machine shops is to maintain a large number of workers at a wage-rate not equal to the best, but perhaps a little in excess of that of the ordinary American operators, and to depend throughout on a class of skilled workers, instead of organizing the factory on labor-saving methods, investing in labor-saving machinery (which never goes on strike), and paying high wages to the few. Even to the uninformed observer, the number of "fitters" in the European machine shop is strikingly large as compared with the number of men doing hand work in the average American shop. Fitting can never be done away with entirely, and a certain amount of hand labor will always be necessary, but to work as near to the finished surface as possible with machinery, and to leave little for the fitter to do, is the aim of the American manufacturer, and it must be the aim of those who would compete with him. To deal with the influence which trade unionism has on the introduction of labor-saving machinery, particularly into English shops, would be but a repetition of facts known to all through the recent strike. It is sufficient to state that trade unions do not in the least affect the American maker of machinery, and the same is practically true of the German maker.

The use of labor-saving machinery, as practised by the Americans, has also the effect of reducing factory expenses, as it makes possible a better working system and organization, a sub division of labor, and an exact inspection. Fewer operatives are necessary where automatic machinery is used, and, as parts are made in quantities, the cost-keeping is simplified and less office work is necessary. Where the work is reduced to "machine" operations, an extensive system of gauging becomes necessary, to which the unskilled operator must work. Not only is it possible to reach a higher degree of accuracy in single operations, but the machine itself presents a less complicated problem for thorough inspection than it does when the old system of fitting is employed. Thoroughly-organized tool rooms follow as a necessity. Every operation must be specialized, and by constant study and experience in one class of work the cost of production is reduced to a minimum.

The moral effect which automatic fast-running machinery has is a factor which neither workmen or employers can despise; but the whole establishment must be brought into harmony with this class of machinery, or its introduction will not be productive of the best results. Labor-saving machinery, as a rule, calls for the best work-

manship in its construction. The standard of excellence will, by association, be gradually raised, and, if good management prevails, all will in time adapt their pace to that of the highly-productive machine. Where labor-saving machinery is introduced, it naturally follows that labor-saving machinery will be produced, and commercial advantages quickly follow, for it is a well-known fact that trade and commerce naturally drift towards those centers where the united efforts of a community result in producing the best article. In spite of protective tariffs, political humbug, and national conceit, industrial and commercial supremacy will assert itself, and, with the aid of the steamship, cable, and postal facilities, will penetrate to the most remote corners of the earth. Whenever it is possible for any one country to produce the highest grade of work, the greater part of the demand of the civilized world for that class of goods will seek supply in that country.

It is well to attempt to answer the question: what constitutes the most effective plant for the production of machine tools? It is that plant which produces the greater part of its work by unskilled workers operating labor-saving machinery kept in order and supervised by the skilled labor of the higher wage-earner. On the contrary, an uneconomical, low-wage-earning factory is one which is equipped with ordinary machines, operated by so-called skilled labor receiving a uniform rate of wages, where the net results are a product which is expensive and neither uniform or of the highest grade. Of the former type is the usual American machine shop; of the latter the average European machine shop. The average wages paid in the American factory are higher than those in the European, and are, in special cases, in excess of anything ever received by the European "engineer." However, the value of the product of the American shop exceeds, proportionally, that of the European by more than the excess in wages. It must be remembered that, to be valuable, a high-priced workman need not necessarily turn out a great quantity of work, and that a low-priced workman may be a very expensive producer, even when turning out large quantities. I have seen in European factories lads attending hand milling machines who forced the parts underneath the cutters at three times the rate of feed that should have been employed, and produced work to which the fitter must have given three times the amount of labor to bring it to a finished state that would have been required if this same work had been put through automatic machines. In the above case a slow automatic feed could be used, and one lad could attend three machines which could be kept in a high state of efficiency by a well-paid toolmaker. The work would leave the machine in a very nearly finished

state, and very little hand work would be necessary. The employer's capital would be invested in labor-saving machinery and high-wage tool-makers, which would yield him greater returns than hand machines and lads at two shillings per day.

The two main factors which enter into the cost of a machine are, of course, wages and material. Some consideration of the materials used by the American manufacturers, as compared with those used by Europeans, will be of interest, for this reason,—that the cost of production is largely dependent on the ease with which material can be worked. Again, automatic labor-saving machinery cannot often be successfully worked unless the highest grades of material are used. It is admitted, by those who have had the opportunity of observing, that it is apparently impossible for the European foundry to turn out a quality of cast iron equal to that generally used in the construction of American machine tools. The price of cast iron for machine tools in America is about the same as in Europe, but the quality is very much superior for machine-tool purposes, and the American pays great attention to securing a quality of cast iron that can be easily machined. In special lines, like that of harvesting machinery, castings are produced for one cent per pound. For most American machines a soft, close-grained iron is used, which is easily worked, and is not very destructive to cutting tools; at the same time, it has good wearing qualities and easily takes a high finish. With such cast iron it is possible to take faster cuts on the planing machines than is usual in European practice, and it also permits extensive and economic use of the milling machine. A prominent English steel maker has informed me that tool steel supplied to America is generally of a lower carbon than that furnished to European manufacturers. This is due to the fact that American iron is uniformly of a softer grade than European. This is certainly an advantage to the American. It is also to his advantage that he is able to purchase at a low price the soft machinery steel so largely used in the construction of machine tools. I know no German or English makers who can supply a good quality of soft steel to compete with that delivered at works in America for one and a half cents per pound. This steel is of soft quality and very uniform, and answers every requirement for a great many parts of a machine tool. It can be rapidly cut, and it takes a high finish. It also runs more accurately to sizes than the European product. This one fact is highly essential for the successful working of certain classes of automatic machinery. In America sheet metals are more accurately rolled and finished, and are lower in price, than they are in Europe. The interesting question as to the comparative merits and prices of materials is too extensive to

be dealt with at this time. However, it is pertinent to state that the use and value of special high grades of material, which enter into the construction of, and are important adjuncts to, the economic working of machine tools, are not yet fully comprehended by European manufacturers, and consequently are not demanded by them. As long as this state of affairs continues, it cannot be expected that European manufacturers of material will exert themselves to compete with American in supplying these high grades at low prices. The first essential—demand—is wanting. It is interesting to note that American manufacturers have not a reputation for supplying the uniform quality of tool steel produced by the best English makers. Many of the best makers of machinery in America purchase their tool steel from England.

A careful study of the situation on the part of European makers of machinery will surely result in the adoption of much of the American practice. The extensive introduction of labor-saving machinery in America is developing a highly-paid, valuable, and efficient type of workman. European employers who, more or less, recognize the advance of labor-saving machinery must, at the same time, realize that they cannot keep to the front if they do not try to secure a class of workers necessary to maintain labor-saving machinery at its highest degree of productivity, by paying wages which intelligent and skilful men must have. Workers who do not recognize the labor-saving machine, not only as the producer of a better and cheaper article, but also as a means of elevating their craft and making higher wages possible, must suffer in competition with other nationalities.

THE AMERICAN ISTHMUS AND THE INTER-OCEANIC CANAL.

By W. Henry Hunter.

THE case for the severance of the isthmus which unites the northern and southern American continents, and thus divides the Atlantic and Pacific oceans, is presented by a glance at a map of the western hemisphere, and, to the mind of one capable of discerning the trend of events in the days in which we live, is established by a study of the same map.

The Atlantic and Pacific form the two great highways of the planet. To them all others are subsidiary,—adjuncts, or in the relationship of attenuated extensions,—whatever their character, their dimensions, or their position. At the Central American isthmus these two great through routes, upon which the commerce of the world and the progress of the nations depend, are divided by a neck of land, which, at any rate on one of the proposed lines of severance, is but some forty miles in width—but five miles longer than the channel excavated by local enterprise for the Manchester ship canal.

If it were necessary to emphasize by any particular claim of special advantage, the general benefit to commerce which would most certainly follow the opening of the inter-oceanic canal, we would base that particular claim, not upon the shortening of the distances between the eastern and western sea-boards of the United States, or upon the political gain to accrue from the reduction of distance between the naval outfitting ports on the northern Atlantic and the Philippine islands,—though these results would be important,—but on the effect which would be produced upon the tropical districts of the west by the construction and working of the canal.

The accomplished author of "Social Evolution" has recently issued a short, but weighty, *brochure*,* in which he has dealt with the general question of the tropical regions,—with their enormous capacities of production, on the one hand, and with the present wretchedness of their condition, on the other hand. He justly describes that condition as "altogether deplorable." He says: "A blight seems to hang over the whole region. There are only two words which adequately represent the condition of the immense territories included—anarchy and bankruptcy"; and he suggests the removal of the blight

* *The Control of the Tropics.* By Benjamin Kidd. New York. The Macmillan Co.

by the substitution, for the anarchy, of strong and righteous government,—that is to say, government by the governing races of mankind, by the great civilising powers of the world.

Anything which will conduce to this will confer a benefit on mankind for which no adequate standard of measurement can be found. It will, in truth, do something to hasten the fulfilment of the poet's vision, when

> Through Orient seas, o'er Afric's plain,
> And Asian mountains borne,
> The vigour of the northern brain
> Shall nerve the world outworn.

No one can doubt that the construction of an international highway through the Central American isthmus will tend to improve administration in the American tropics, to the nerving of that "world outworn" by "the vigour of the northern brain"; for this reason, then, if for no other, the isthmus *must* be severed, and the international highway made.

There are other reasons for the construction of this great junction of the seas,—reasons so many and so weighty that they have impressed men of perspicacity and enterprise for generations past, from Hernando Cortés to Ferdinand de Lesseps; men who were in advance of their time, men who saw clearly when other men were blind, men who agreed as to the necessity for the junction, but who differed as to the manner in which it should be effected.

Out of their differences arose the different schemes propounded from time to time: for a canal on the Darien line; for a canal on the Panama line; for a waterway (formed of junction canals at either extremity and of an existing inland sea) on the Nicaragua line; for a ship railway on the Tehuantepec line, which was the project of the late Captain Eads; and others of lesser importance.

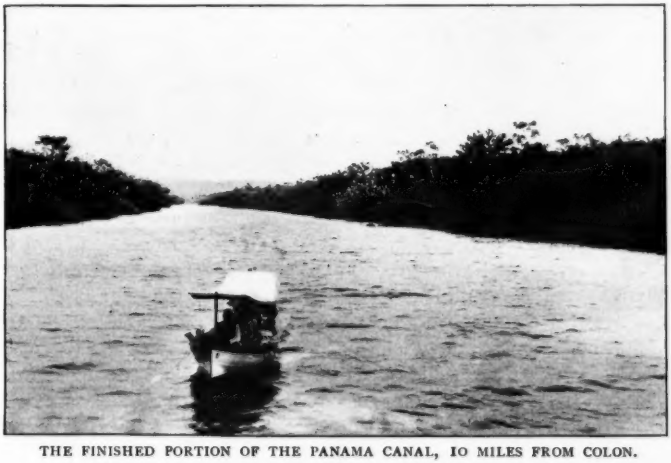
Of these schemes but two survive,—the Panama canal and the Nicaragua waterway,—and their respective promoters and supporters struggle for the mastery.

As is usual in such case, all manner of side issues are being raised in the struggle; herrings are being trailed across the track, and considerations, some of them very unworthy, having no real bearing upon the point at issue (which ought to be simply the determination of the best and most appropriate method of achieving the desired purpose), are being dragged into the discussion by heated advocates and by indiscreet partisans.

Against this the minds and instincts of men of science must revolt. A scientific question of vast importance to humanity cannot be settled by appeals to international jealousies and racial hatreds. These

are, alas! all too easily aroused. Political equilibrium is proverbially unstable, and mutterings about "control," once set going, soon serve their purpose of disturbing that unstable equilibrium. Then prejudice takes the place of argument, and rhetorical invective does duty instead of facts and figures.

We desire to avoid, in these pages, all extraneous questions, and to present, with such brevity as the circumstances will admit of, the salient features of the two rival routes, hoping that in this way we may be able to contribute to such a solution of the problem as will commend itself, by its loyalty to sound engineering and economic principles, to the minds of all competent and impartial judges.



THE FINISHED PORTION OF THE PANAMA CANAL, 10 MILES FROM COLON.
It is completely excavated to this width for 24 kilometers—14.9 miles.

I.—THE PANAMA ROUTE.

It is to the credit of M. de Lesseps that he advanced further than any of his predecessors in title in promotion of the Panama canal, in that he made a determined effort to achieve that which they had but desired.

The effort ended in disaster; disaster which is now a matter of common notoriety, and of which the story has been told often and in terms so fittingly unsparing that the public mind has come to regard it as irretrievable, and, in some measure, to look with prejudiced eye upon any attempt to convert the disastrous failure into a meritorious success.

In 1888 M. de Lesseps's company collapsed. What is now known as *l'ancien compagnie* stopped payment, and, in accordance with

the requirements of the French law, a searching and extended examination of its affairs and its administration was made by duly-qualified legal officials.

The result was twofold. In the first place, there was a scandalous exposure of malfeasance, the like of which has not been seen since the days of the South Sea Bubble, followed by criminal proceedings in courts of competent jurisdiction. In the second place, the skilled and impartial officials to whom the examination was committed became possessed of two decided convictions: (1) that the Panama canal could be made and should be made; (2) that *l'ancien compagnie* had really done more towards the achievement of the waterway than it had at first been given credit for, and that the work which it had executed could be advantageously utilised in a renewed effort to effect the completion of the canal.

Impelled by these convictions, *les mandataires de justice* themselves took action, after several abortive attempts at reconstruction had shown the helplessness of the representatives of the old company.

To appreciate the difficulties with which the liquidators were confronted at the time at which they intervened,—say, at the end of 1893,—it is necessary to recall one particular of their entangled environment.

The government of the republic of Colombia had granted to the old company a most valuable concession, by which that company was not only authorised to make the canal, but placed in possession of some 15,000 hectares of land upon the route of the canal, on which the company had erected workshops, stores, hospitals, administrative buildings, etc., at a prodigious cost; and upon which it had also collected masses of plants and materials.

It was necessary, if this great concession was to be preserved, that, on or before October 31, 1894, the works should be re-started "*d'une manière serieuse*"; there was to be no humbug about it.

There was, therefore, but little time for carrying through the intricate arrangements which had to be made; but the liquidators faced the situation with stout hearts and hopeful spirits. They entered into negotiations with some of the great financial houses in France, and secured their powerful support. They also made representations of an effective character to certain of the persons who had profited by transactions with the old company, and informed those persons that, in the judgment of the liquidators, it was desirable, in their own interest, that they should subscribe the funds required for the re-opening of the works in the isthmus. Further, they obtained special powers from the French legislature, and finally they established upon a firm and substantial basis "La Compagnie Nouvelle du

EXCAVATORS AT WORK IN A CUT.

THE PARTIALLY-COMPLETED CANAL AND THE PANAMA RAILROAD.

THE CANAL AT EMPERADOR. AMERICAN CABLEWAYS AT WORK.

THE CANAL 32 MILES FROM THE ATLANTIC, LOOKING TOWARD COLON.

Canal de Panama," with a capital of 65,000,000 francs, or about £2,600,000.

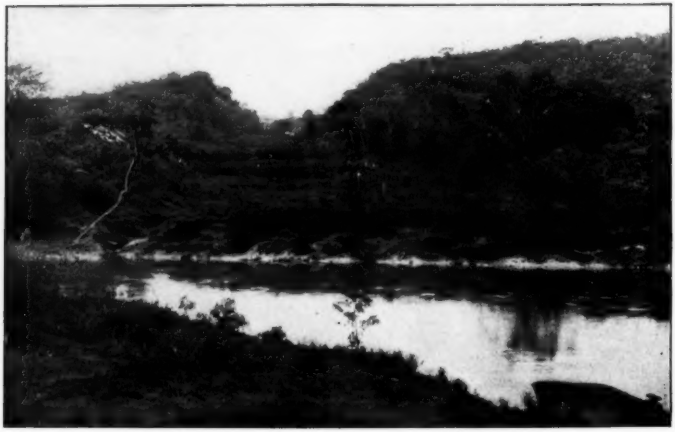
The new company was definitely formed on October 20, 1894, just eleven days before the date on which the concession would have lapsed. The margin was very small, but it was enough; for vigorous measures were taken, the concession was saved, and the directors of the new company set about the discharge of the duties which they had undertaken. These were: (1) to preserve the concession; (2) to prove experimentally whether the construction of the canal was feasible; (3) if shown to be feasible, to prepare a project for construction, which would command the confidence of impartial men in the engineering, financial, and commercial world.

Some indication of the manner in which the duties have been discharged is afforded by the following particulars:

(1) In 1895, the company employed 3,000 men, and 370,000 cubic metres of material were removed; in 1896, the figures rose to 4,000 men and 700,000 cubic metres; and, in 1897, to 3,600 men and 960,000 cubic metres. Thus the terms upon which the concession was originally granted have been complied with, and work of substantial and permanent value has been carried out. Some idea of its extent may be gathered from the accompanying engravings, made from photographs taken on the spot.

(2) It was felt that three special difficulties, inherent and peculiar, confronted any would-be constructors of the Panama canal.

(*a*) The regulation of the river Chagres, a capricious tropical



SITE OF THE BOHIO LOCK. CUT OF 160.7 FEET.

THE CULEBRA CUT. THE GROUND ORIGINALLY EXTENDED FROM ABOVE THE CREST ON THE LEFT TO THE HOUSE ON THE RIGHT-HAND BANK.

stream, flowing from east to west, discharging into the Caribbean sea to the westward of Colon ; now winding its way in gentle stillness to the ocean, anon breaking out into torrential turbulence and foaming down its valleys in fierce floods for days together. This unbridled water course formerly cut the line of the canal at a dozen different points, presenting an obstruction at each. To avoid these obstructions extensive river diversions have been formed, through which the river now flows, and which have proved effective at all times except those of heavy floods. To provide for these much more extensive works will be required.

(*b*) The cutting through the Cordilleras, which, on the line of the canal, form the "divide" between the watersheds of the Atlantic and the Pacific.

Great uncertainty existed as to the character of the material to be excavated, particularly in the two heights, which stand in proximity to each other, to the southward of the centre of the isthmus ; the more northerly height being known as Emperador, and the southerly (and greater of the two) as Culebra. To determine the real nature of the material, the directors decided to drive a "*cunette preparatoire*" through the peaks Emperador and Culebra.

In modern surgery, when uncertainty is felt as to the diagnosis of some internal trouble in a patient, the surgeon is as likely as not to proceed to make what he euphemistically describes as an "exploratory incision," which means that he cuts into the living man, in order

to ascertain with precision what the nature of the sufferer's malady is.

The *cunette preparatoire* was an "exploratory incision" made in clay and schist and rock instead of in the living fibres of a human body; and the result of its execution (taken in conjunction with the results of numerous borings which were made and of trial bits which were sunk) was to demonstrate in an unquestionable way, that the

THE CANAL AT SAN PABLO, 23 MILES FROM THE ATLANTIC.

strata through which the canal cuttings will pass are of such a nature as to relieve the promoters from all fear of disastrous slips or landslides, either during or after construction.

(*c*) The climatic conditions under which the work must be undertaken, and the lack of efficient sanitation.

It is commonly reported that, in the course of the construction of the Panama railroad, which was carried out by an American company, and of which the route is nearly identical with that of the proposed canal, the laying of a sleeper or tie and the burying of a Chinaman were operations which were conducted concurrently by the constructing company. There is much of picturesque exaggeration about the statement, but undoubtedly the mortality was very heavy in those days, as it was also in the days of the old canal company.

The past, therefore, has been unfortunate; it is also irretrievable. But, learning from past failures, the new company proceeded on lines different from those followed by its predecessors. Drainage works were undertaken; sanitary regulations were enforced; the health of the employees was watched over; efforts were made to confine the

immigration of workers to persons whose constitution and habits of life fitted them for residence and labour in the tropics.

The effect of all this, taken in conjunction with the works executed, has been an almost sensational degree of success. The route has been opened throughout its entire extent by means of the partially-completed cuttings; the trees and jungle-like undergrowth have been cleared from the line; thus an air channel has been formed, in which deadly stagnation has been replaced by revivifying currents, which pass as fresh breezes from sea to sea.

It has been proved by trial that coloured labourers can work all the year round in the isthmus; that, of the number employed, at least 97 per cent. may be expected to be at work in perfect health at one time; that yellow fever and the other dread ailments of tropical swamps are not indigenous to Panama; and that, with ordinary care, Europeans may live there for years together without experiencing, by the fact of such residence, any serious increase of the peril of death in which all men always stand.

CANAL EXCAVATION AT LA COROSITA, 28 MILES FROM THE ATLANTIC.

The directors of the new company may, therefore, justly claim that they have fulfilled the following functions: (1) preserving the concession; (2) demonstrating the practicability of the construction of the canal; (3) coping with the climatic conditions of the isthmus.

But a further duty devolved upon them,—*viz.*, that of preparing a project for the completion of the canal as a permanent work and as a navigable waterway,—a project which would, despite the previous

failures of the old company, command the confidence and enlist the sympathies of competent men of all nationalities.

In the discharge of this duty they obtained the best engineering advice available, and formed a competent engineering staff. In addition to this, acting under special legislative enactment, they summoned to their aid a number of outside engineering experts,—French, German, Russian, American, and English: all of them men holding, or having held, responsible positions, impartial in judgment, and possessed of such experience as to render each man specially fitted to advise on the proposed design and method of construction.

In this way the *Comité Technique* was formed.

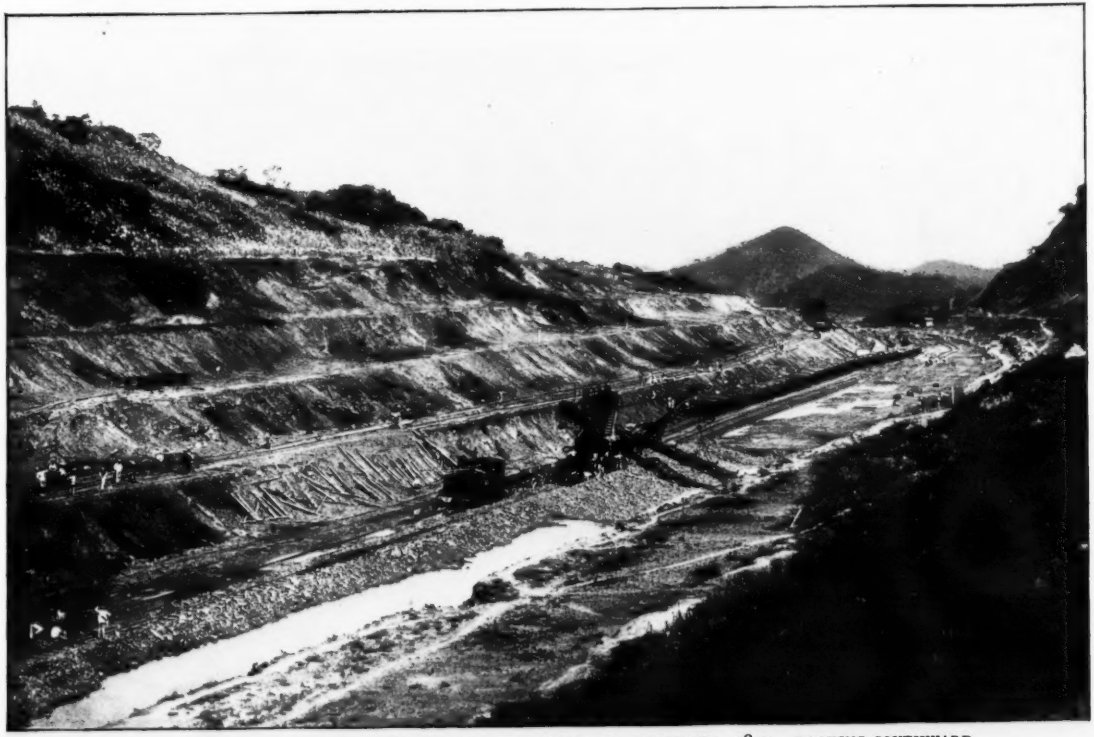
The *Comité Technique* was no merely ornamental appanage; the position of its members was by no means of an honorary sort. In

THE CANAL 33 MILES FROM THE ATLANTIC. FRENCH EXCAVATORS LOADING CARS.

conjunction with the directors and the leading officers of the company, it held nearly one hundred protracted sittings between the beginning of 1896 and the end of 1898, at which the whole of the main lines of the project were considered in closest detail.

As an example of the conscientious and painstaking way in which the members of this joint board discharged their duties, it may be noted that no less than sixteen different proposals for the arrangement of the longitudinal section of the canal were discussed by the board, and the pros and cons of each weighed, before a final decision was arrived at, troublesome and laborious though the process was.

Thoroughness characterised the whole of the proceedings of the board; nothing was left to chance; everything was, as far as possible,

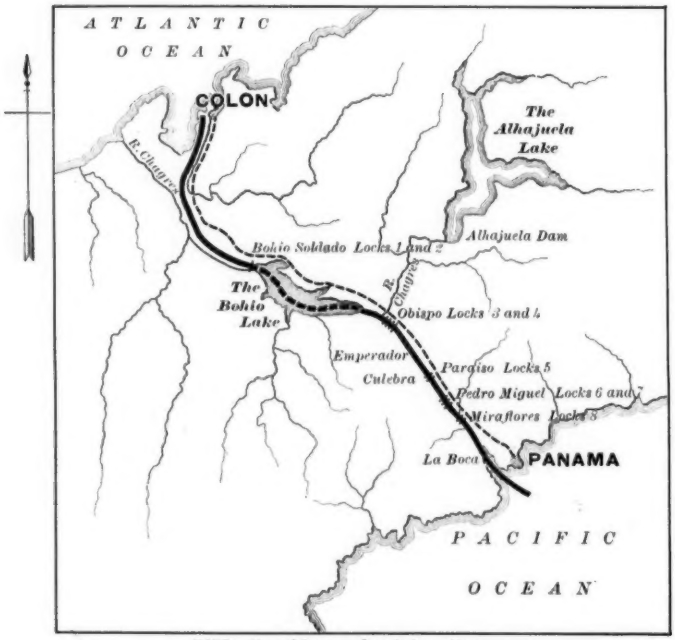


THE GREAT CULEBRA CUT, 34 MILES FROM THE ATLANTIC, SEPTEMBER, 1897. LOOKING SOUTHWARD.

ascertained. Under the direction of the *Comité Technique* the whole of the route of the canal and of its collateral works was accurately surveyed and contoured; borings were made, trial pits sunk, streams large and small, (including the wayward Chagres) gauged, meteorological observations made and recorded, and generally a mass of facts accumulated through which the *Comité* was enabled to agree upon a project for the completion of the Panama canal, with which the new company is prepared to face—indeed, to invite—the criticism of the world.

The project, thus elaborated, is indicated on the plan (Fig. 1) and longitudinal section (Fig. 2) shewn on this page and the page opposite. The necessarily minute scales of the plan and section forbid the introduction of any detail; it is hoped, however, that the following brief descriptions will make the little drawings clear to non-technical as well as technical readers.

The termini of the canal are Colon on the Atlantic coast, and



NOTE. Line of Panama Canal shown thus ——

FIG. 1. PLAN OF THE PANAMA CANAL.

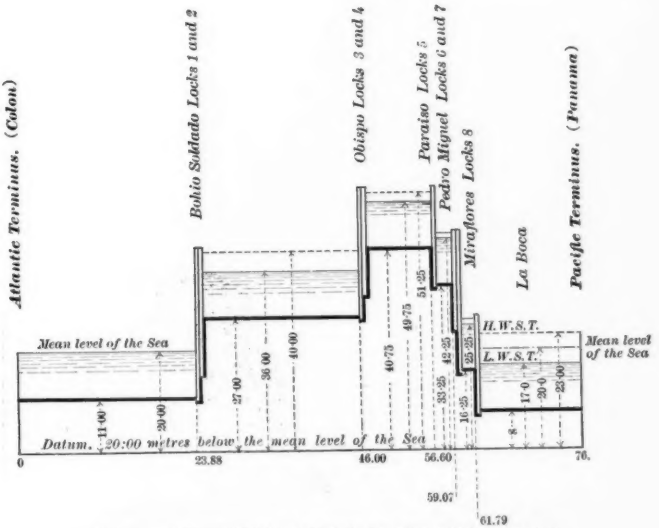


FIG. 2. LONGITUDINAL SECTION OF THE PANAMA CANAL.

This section shows the "Mean-Level Dividing-Lock System"; two other plans were considered by the *Comité Technique*—the High-Level, with the bottom of the summit level 29.75 metres above sea, and the Low-Level, with the bottom of the summit level only 9.75 metres above sea. The canal, on the present line, can be brought down to sea level whenever the conditions warrant the expense.

Panama on the Pacific. A line joining these two points would run, approximately, north-west and south-east. The distance between them is 42 miles, measured as the crow flies, and 46½ miles, measured on the line of the canal.

The canal is to be divided into six reaches; a maritime channel is to be formed on either sea-coast, and these channels are to be connected by four intermediate ponds of varying lengths.

The channel on the Atlantic coast covers nearly one-third of the length of the canal, being itself 24.20 kilometres in length. The bottom width of the channel will be 30 metres, and the depth below the mean level of the sea (which is here practically tideless) will be 9 metres. The Atlantic channel (which is already completed, requiring but comparatively small quantities of dredging to give the full width and depth) will terminate on the flank of a hill at Bohio Soldado, where the first group of locks will be formed. The Chagres passes near to the site, the valley in which the river-bed lies being comparatively narrow at the place, confined as it is by high ground on either side. Advantage has been taken of this natural formation, in the design of the canal works.

EXCAVATOR AT WORK AT THE EXTREME WESTERN END OF THE CULEBRA CUT.

It is intended that the valley of the Chagres shall be closed by a great embankment of earthworks, so constructed as to form a water-tight dam. By this means a vast lake will be formed behind the Bohio locks, the effect of which in the regulation of floods will be considered later. As an adjunct to the dam, a channel for the discharge of flood waters, which will be controlled by sluices of the Stoney type, will be constructed at Bohio.

The second reach of the canal will extend from Bohio to Obispo (a length of little more than 22 kilometres), and will, for the most part, be formed through the great Bohio lake, the width at the bottom being 50 metres, and the height above the mean level of the sea 7 metres. At Obispo a second group of locks is to be constructed, and at this point the summit-level of the canal will be attained, the reach from Obispo to Paraiso, where a single group of locks is to be built, forming the "divide" of the canal, or, as the French say, *le bief de partage*. The length of the dividing reach will be 10.65 kilos, the bottom width 36 metres, and the height 20.75 metres above the mean level of the sea.

Then will follow two short ponds from Paraiso to Pedromiguel, and from Pedromiguel to Miraflorés. A double group of locks will be built at Pedromiguel, and a single group at Miraflorés, the respective lengths between the locks being 2.50 and 2.70 and the respec-

tive levels at the bottom of the ponds being 13.25 metres above, and 3.75 metres below, the mean level of the sea, the width at bottom being 30 metres in each case.

At Miraflorés the level of the Pacific will be reached. The Pacific channel will be 12.70 kilos in length, divided into two parts, of which the first will extend from Miraflorés to the port of la Boca, and the second from la Boca to the terminus in the ocean. The width of the first part at the bottom will be 30 metres, and of the second 50 metres, the level of the bottom being 12 metres below the mean level of the sea, a tidal range of about 6 metres being experienced in the gulf of Panama at spring tides.

It will be noted that, in the foregoing description, the levels given, have, in all cases, been of the bottoms of the intended channels and ponds. A minimum depth of water of 9 metres will be maintained throughout, but provision will be made which will permit of a considerable increase of the depths in the various ponds during times of flood, while at high water of spring tides the depth in the Pacific channel will be increased to 15 metres.

In the design of the canal, of which the leading features have been thus indicated, the answer to the crucial questions (1) as to the alimentation of the "divide" and (2) as to the regulation of the floods of the Chagres have been answered in a proposal as bold as it is free from complexity, and, so far as can be foreseen, as certain to be effectual as any engineering effort to control the forces of nature can well be.

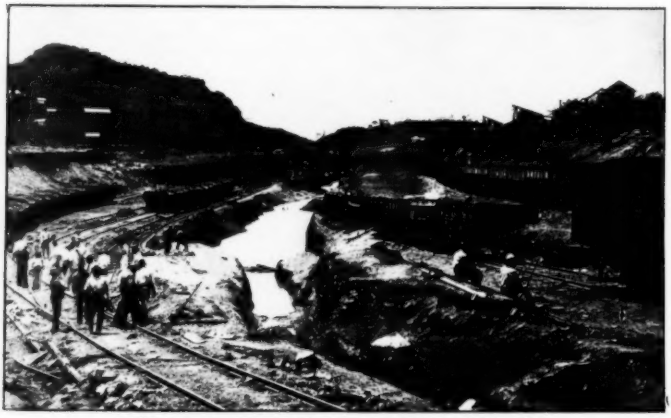
The detailed surveys of the upper valleys of the Chagres brought

THE WESTERN END OF THE CULEBRA CUT.

into prominence the fact that, at a place bearing the uncouth appellation of Alhajuela, and lying about 16 kilos to the north-eastward of the lines of the canal, the river flows through a rocky gorge which forms a constriction of such sort as almost to lead one to regard it as a special provision of nature for the assistance of her sons in their effort to control some of her more turbulent forces.

In this rocky gorge, on the rock of which it is formed, and of the rock by which it is surrounded, it is proposed to construct a great dam, after the style and character of that built by Mr. Fteley as a part of his magnificent works for the water-supply of New York.

The proposed dam will be about 286 metres in length, measured along its crest, and about 50 metres in height, measured from foundation to summit at the deepest part of the valley.



OUTLET OF THE CULEBRA CUT ON THE PACIFIC SLOPE.

Behind this dam a second great lake will be formed, in which the minimum level of the water will be 58 metres and the maximum level 67 metres, thus furnishing a vast capacity for the storage of flood waters, which can in this way be impounded and employed as required for the feeding of the canal.

Between the dam and the line of the canal a *rigole d'alimentation*, or feed-water conduit, will be formed along the flank of the high ground on the left bank of the river; this conduit will be similar in many respects to the "flumes" of California, and will serve the same purpose as they do, and in the same manner, but on a larger scale.

It is unnecessary to cumber this review with descriptive particulars of the manner in which it is proposed that the different works

shall be executed, and of the progressive steps to be taken and stages to be reached, season after season, year after year. All this has been elaborated thoroughly and in patient detail, but need not be dwelt upon here. Neither is it necessary that we should attempt to epitomise the volumes of calculations which have been made of the flow of the Chagres, whether in respect to the whispering trickle of its stream in times of extreme drought, or the roar of its turbulent torrent in times of greatest flood. Figures without explanation are misleading, and, even with explanation, form but dry and uninteresting reading, except to statisticians—a limited class; and we confess to a desire to make this review serviceable to the largest possible number of readers, seeing that the matter of which we treat is one of profound importance for humanity at large, and of importance not only for the present day and for the present generation, but for days yet in the future and for generations yet unborn.

By the aid of the regulating works already described, it will be possible to work the canal in perfect safety at all times, and to hold even the greatest floods under perfect control.

Ordinary freshets and floods of small degree will be stored in the Alhajuela lake alone, whence their waters will be allowed to flow through the conduit, and in such quantities as the traffic may require, to the "divide" of the canal. Careful calculations have shown that a sufficient quantity of water can be impounded in the lake and between the planes of maximum and minimum water to feed the canal for more than twelve months, even if a single drop of rain did not fall within the limits of that period. It may be safely said that no such drought has taken place in Central America since men appeared on this planet, nor will take place until the day comes when the planet's "elements shall melt with fervent heat."

The construction of the Alhajuela dam will therefore provide for the alimentation of the canal at all times, and for the regulation of ordinary floods.

For the great and exceptional floods the storage capacity of the Alhajuela lake will be supplemented by that of the lake at Bohio. Provision has been made for raising the level of the Bohio lake by 4 metres. Special arrangements have been devised whereby the surplus water from Alhajuela may pass down the old course of the Chagres, through the dividing reach, and thus flow into the Bohio lake, whence they will be allowed to pass on their way to the ocean through the various river diversions in such volumes and over such times as the engineers in charge of the working of the canal may determine.

Given accurate data to work upon, the results arrived at by hydraulic calculation are absolutely certain and reliable. Such calcula-

tion shows * that a steamer will be able to pass from end to end of the Panama canal at the height of the tropical rainy season and at a time when the Chagres, if left to its own devices, would have been boiling down in tempestuous flood, without finding a current at any point, either with or against her course, of more than two miles per hour.

The promoters of the Panama canal therefore claim, and, it must be admitted, with some reason, that in their project the bogie of the Chagres floods has been effectually laid.

But little is required to complete this brief description of the outlines of their project. The route has been judiciously selected, and the line carefully laid out. More than half the total length is absolutely straight on the plan, and for the remaining portion the curves are so easy as to be practically negligible from the point of view of navigation. It will have been noted from the description already given, and will be seen in Fig. 2, that there will be eight sets of locks in all, four on either watershed. The locks will in every case be constructed in pairs, a larger lock and a smaller lock lying side by side. The dimensions of the larger lock will be 225 metres (working length) by 25 metres, with central depth of 10 metres; of the smaller locks, 225 metres by 18 metres by 10 metres. It is proposed to equip the smaller locks with intermediate gates. Approach basins will be formed above and below the locks, and the mid-feather, or pier, separating the adjoining lock chambers will in each case be prolonged into these basins, so as to form a jetty for the guidance of vessels.

Taking into account the value of the work already executed, and pricing the work yet required at the rates at which the comparatively small works of the last three years have been carried out by the new company in the isthmus of Panama, it is estimated that the canal can be completed, equipped, and opened for traffic at a cost of £20,000,000 sterling, or $100,000,000, including the cost of administration as well as interest paid out of capital during the period of construction.

The time required for completion, if all things go well from first to last, and if serious *contretemps* do not arise, will be about eight years. So uniform good fortune, however, does not often fall to the lot of constructors of public works; it is therefore proposed to add 25 per cent. for contingencies, making the estimate of time required for completion ten years; *i. e.*, if the constructible work is proceeded with vigorously from the present time, the Panama canal will certainly be opened to the traffic of the world on New Year's Day, 1909.

* In the desire for the entire elimination of the personal element from these articles, allusions to the names of individuals have been avoided. Competent critics, both in England and America, will, however, accept the results of these calculations more willingly if we add here the statement, that the calculations throughout have been made by General H. L. Abbot, late of the United States corps of engineers.

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

FEW people realize, in the multifarious forms of industry carried on around them, the extensive portion that comes under the head of wood-conversion. Of the three principal materials of construction,—wood, metal, and stone,—wood is the most extensive and conspicuous, wrought into a thousand shapes of use and ornament, and performing a wide range of structural functions. It meets one's view wherever the eyes are turned, and not only is the most familiar of all natural substances in an artificial state, but, next to earth itself, is the most familiar of all objects in its natural state.

Down to a century ago wood was not only the principal structural material, but almost the only one that engaged attention in the common mechanic arts. The carpenter, millwright, engineer, and shipbuilder wrought principally in wood, and, when the penitentiary system was introduced in England about 1790, the only branch of industrial work carried on in the prisons was wood-working. Some accounts of this will be given further on.

The importance of a structural material of any kind diminishes in popular estimation when the tendency is away from, instead of towards, it. New material attracts attention far beyond its real importance. We are scarce beyond the period when aluminium engrossed public attention as a structural material, and gave rise to extravagant fancies out of all proportions to the modest place this metal now holds. It was the last; but for two centuries past there has been a constant search, to some extent successful, for substitutes for wood. Yet it remains the chief material for structural uses, or at least is the most common and useful—the one that could least be spared, and without which the whole domestic economy of life would have to be changed.

Considering these circumstances and the antiquity of the art, we would naturally expect the implements and processes in wood-working to be the most advanced of all. This is not the case, however. The age of the art has little to do with progress in this direction. The application of machine-processes was contemporaneous in all kinds of industry, or nearly so, and is little more than a century old,—a fact hard to realize at this day, when hand-work has so nearly

disappeared. The steam engine as a motive power came in with this century, and there are yet living about Soho, in England, men who in their childhood saw James Watt and the factory where steam power had its practical origin.

It seems, too, that the hand-processes in wood-working, an art universally known, offered a resistance to machine-processes greater than that which was met in many other branches. It must also be remembered that many branches of industrial art had their origin in

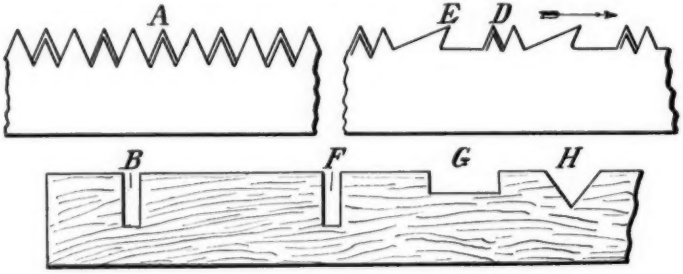


FIG. 1.

machine-processes, and so were spared the task of displacing traditional customs and skill; hence the progress of wood-converting machines was less rapid than the application of new implements in many other branches, such as metal working and the conversion of fibrous materials.

The principle, or manner of operating, in nearly all wood-converting processes is that of cutting, or by edges—the cleaving wedge, so to call it; the edge being so impelled and guided as to cut away the surplus material and leave the finished form required. There are other processes, such as abrasion, bending, and embossing, but "cutting" comprises nearly all.

There is a near analogy to metal-working, in which the machines and implements are directed to cutting away surplus material, producing planes, cylindrical forms, and sometimes irregular forms; but the operating conditions are different. In cutting and shaping metal by means of edges, a limitation of rate is found in temperature. The material is homogeneous, and can be cut alike in all directions, but only at a slow rate, because of its hardness and the heat generated, which must have time to pass away, by convection and otherwise. Cutting edges rarely move more than ten to twenty feet per minute when acting on iron or steel. The process is slow and expensive, accordingly.

In wood-cutting by machines there is, however, no such limita-

tion. The material is soft, and the movement of edges can be from two to four thousand feet per minute, or as much as the cutter-supporting devices will permit with safety. The product, or area prepared by machine-cutting, is in proportion, and the result far beyond what inference or conjecture would suggest. For example, a surface planing machine operating on both sides of boards 16 inches wide at the rate of 33 lineal feet per minute will prepare and thickness more than 50,000 superficial feet, or one and two-tenth acres, of surface in ten hours.

The economic effect of this becomes apparent, when it is contrasted with hand-work. To operate such a machine requires about 10 h. p. and two attendants. The fuel is furnished by the chips or shavings. Maintenance, oil, etc., at fifty cents a day, represents a fourth of one man's wages, making the whole expense equal to the wages of two and a fourth men. By hand-work these men could plane and thickness not more than 300 feet a day, in a much less perfect manner; so the machine will do 166 times as much work.

In preparing matched, or tongue and groove, work, such as flooring and ceiling, the difference is greater,—not less than 250 to 1,—and in making mouldings not less than 300 to 1. In sawing, turning, mortising, and other operations the same remarkable gain over hand-work appears.

The short period within which these results have been attained is appreciated when we consider that there are many people now living

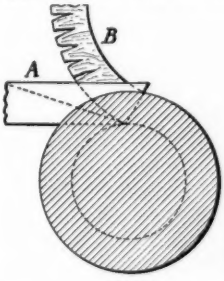


FIG. 3.

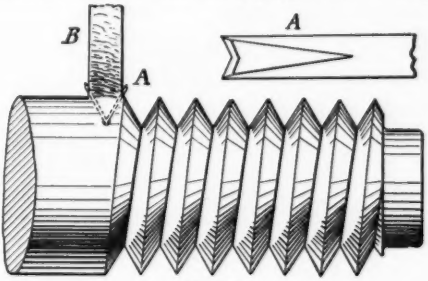
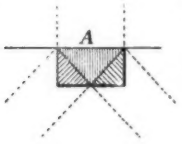


FIG. 2.

who can remember when joiner work, including even flooring and ceiling, was nearly all planed by hand,—a laborious process that did not in most cases include thicknessing, and was consequently an inferior method, except perhaps as to finished surfaces; and even this exception is not to be made in comparison with the fixed knife planing machine employed in Europe and, more notably, with smoothing machines invented in the United States.

Measured by manual energy, which may be taken as 2,500 foot-pounds, or one-thirteenth of a horse power, for a strong man, it would take 130 men to equal the planing machine before named; but there is a difference in favor of the machine in the guidance and application of the cutting edges that justifies the ratios before named.



These comparisons convey an idea of the extraordinary economic results of machinery attained in the principal processes of wood-conversion. They seem incredible, but there are no longer means of comparing, because values are now adjusted to the machine-product alone, and hand-work no longer exists.

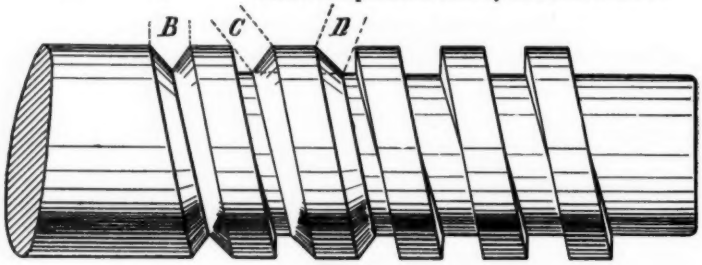


FIG. 4.

These results of machine-processes are, of course, not uniform. The functions of machines are not confined to the application of power. In some cases their dynamic effect is much less than that which a man can achieve, and machine action is confined to accurate guidance, or the production of true forms, as in the making of small articles, like spools and whip-stocks; but such cases do not alter the general result. Indeed, the gain by guidance in such work equals, if it does not exceed, the gain by power in the heavier operations.

The economic effects produced by such a revolution as this in one of the chief branches of human industry, within a century, has been a chief factor in what we call modern civilization; is accountable for many of the changed social relations of our time; and is, in fact, so extensive that no one can trace its effects. It is evidently nearing culmination. This is proved by the slow gain in machine-effect now going on, and a gradual approach toward standard and uniform practice in making and operating machines.

It is customary to predicate the future upon the past, and to assume that the rate of progress in manipulative processes will go on. This might be true if machine-processes came about as a matter of natural evolution, but such is not the case. Machine tools are a

"discovery" that moved with cumulative advance for a period; then began to crystallize into a system of uniformity; next, by organized production, began to divide into special machines; and now proceeds by slow degrees on a "narrow margin," as it is called. There is improvement all the time, but no longer revolution.

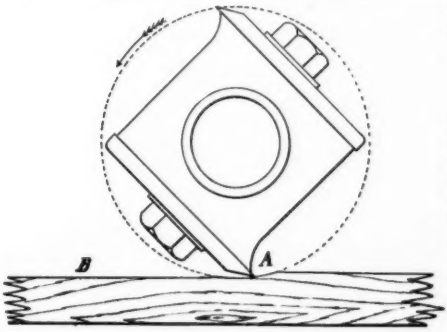


FIG. 5.

The first machine or power operations, it appears from such records as are available, were carried on in Holland, beginning about the middle of the last century, and were confined to sawing machines, especially in preparing ship timbers and fittings, an industry then extensively carried on in that country, as it is still, modified by the progress of engineering.

Circular and other saws were made and used, but to what extent and in what manner it is difficult to ascertain from any accounts in our language. Rotary saws driven by power were introduced into England about 1777, as shown by patents granted at that time,* but there is no evidence of rotary cutters being employed for shaping as well as dividing wood before the subject was taken up in England in 1790 by Sir Samuel Bentham, who devised and practically made and applied nearly all the principal machines now used in wood-converting processes.

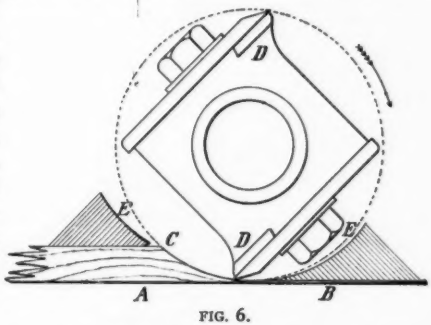


FIG. 6.

Sir Samuel Bentham was unquestionably the most skilled constructing engineer of his time, not only in devising implements to perform various industrial operations, but in discovering the nature, limitations, and possibilities of such operations, or their "analysis," it may be called. His title was that of inspector-general of dock-

* *Vide* British Patent No. 1152, of 1777.

yards, an office created especially to call his qualifications into use, and which expired with his term of service. Previous to his appointment to this special position, he had, under a commission from the emperor of Russia, erected various works in that country for the manufacture of glass, cordage, and other commodities, and had also, while there, turned his attention to a machine for planing wood, which he patented in England in 1791. This machine was, however, a reciprocating one, and was soon abandoned.

General Bentham's main invention and discoveries in wood-converting machines came about in a singular manner. His brother, Jeremy, the author of Bentham's "Jurisprudence," proposed and carried into effect in England the penitentiary system for prisons, now spread all over the world, the especial feature of which is to employ the prisoners at some kind of productive labor.

At that time wood-working presented the only field suitable for such labor; but it was foreseen that unskilled men could not perform successfully even the coarser kinds of mechanical work, and Sir Samuel Bentham was called in to devise machines whereby the unskilled prisoners could work in wood. A factory to make such machines was established in London at Queen's Square place, Westminister, Mr. Jeremy Bentham's residence, and another at No. 19 York street, in the same vicinity, where were made a great variety of wood-working machines, at first for the prisons, and afterwards, by direction of the government, for the dockyards at Portsmouth and elsewhere.

These machines are fully described in Bentham's patent of 1793, No. 1951, now out of print, and no doubt, all things considered, the most remarkable patent on implements ever granted by the British government. In a Crown trial at law in 1848 there occurs the following remark by the justice, in his summing-up of the case:

"Sir Samuel Bentham was the first to introduce saw-mills into our national arsenals; the first also to lay down the principles of all kinds of machine saws that may be constructed, and which have never since been materially departed from. The specification of his patent of 1793 is a perfect treatise on the subject; indeed, the only one worth quoting that has to this day been written on the subject."

In 1852 Prof. Willis, in a lecture delivered before the Society of Arts in London, in speaking of Bentham's inventions and machinery, said:

"There were constructed machines for all general operations in woodwork, including planing, moulding, rebating, grooving, mortising, and sawing, both in coarse and fine work, in curved, winding, and transverse directions, shaping wood in complicated forms, and

that further, as an example, that all parts of a highly-finished window-sash were prepared, also all the parts of an ornamental carriage-wheel were made, so that nothing remained to be done by hand but to put the component parts together."

These machines, as Professor Willis indicates, were for sawing, planing, mortising, and working wood in straight, circular, and irregular forms, for making cabinet ware, carriage wheels, and other

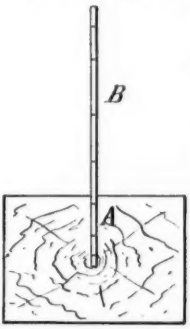


FIG. 7.

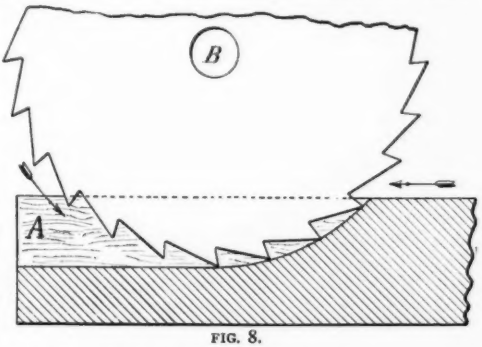


FIG. 8.

things of the kind; they were made and furnished to the government and applied in the penitentiaries and dockyards, the accounts showing that the sum of £16,000 was paid to Bentham for such machines, and that a further sum of £20,000 was voted to him as a premium, estimated to be the saving effected by the machines for one year in the dockyards alone.

These machines included the celebrated block making machines yet in use at the Portsmouth dockyard, of which the government had models made and deposited in the Kensington Museum at London about twenty years ago. These machines, which the writer examined at Portsmouth in 1872, are remarkable examples of ingenious design. They were made about 1790 by Sir Samuel Bentham, assisted by Isambard Brunel, the elder of the two noted engineers of that name, who devised the machines for "turning block shells,"—the most ingenious of all in the set, or system.

A considerable space has been devoted to this account of General Bentham's inventions, because of their extraordinary character and the equally remarkable fact of their being absorbed by the government instead of passing into common practice. One hindrance, no doubt, was the comprehensive patent granted to Bentham in 1793, and the inability of people at that day to understand so sweeping an innovation in a manufacture previously performed by hand; another

was the antagonism of workmen, who burned the first saw mills erected in London.

In 1802 followed the implements of Joseph Bramah for wood planing. This invention relates to what are called transverse planing machines, in which the axis of the cutter's revolution is normal to the faces acted upon, commonly known in the United States as "Daniels planing machines." The Daniels machines differed from those of Bramah in the important feature that the cutter shaft was suspended centrally above the timber to be planed, so that the cutters could operate over a width equal to their whole sweep, while in the Bramah machines the cutter shaft extended below the timber at one side, the cutters operating over less than half their sweep and in a less favorable manner.

The American improvement was important; the machines spread all over the country, and are yet in use where accurate work is required. Further explanation of the action of these machines will be given later.

Six years afterward William Newberry, of London, invented band-sawing machines, and, in a patent granted to him of that date, illustrated his invention in a complete manner. The machines had iron frames, canting tables, feeding rollers, and devices to guide the material. A drawing of this machine will be given hereafter.

This was a complete conception of the band saw, and to the inventor must have given hopes of revolution in sawing processes; but he was doomed to disappointment. The invention had to wait for the inevitable course of evolution, which required in this case more than two generations and is not completed yet. When we consider how simple this invention is,—that of an endless strip of steel stretched over two pulleys,—it seems as though it should be completed, perfected, and applied at once. It affords us a lesson in the limitations that confine human powers, in even the simple branches of constructive art.

The saws themselves were the principal impediment, although the apparently simple machine itself has passed through a long train of modifications, as will be hereafter explained. Newberry's invention of band saws is the first of which clear records exist, but there is no doubt that the same thing has been invented many times and in various countries.

In 1822 there came from several sources the invention of duplicating, or pantagraph, machines that grew into an extensive and important class employed for irregular forms, such as shoe-lasts, gun-stocks, spokes for wheels, implement handles, and the like. In the British patent office, which forms the storehouse of inventions for two hun-

dred and fifty years past, the pantagraph principle in machines is traceable to Blemchase and Boyd, and later to Blanchard in the United States; but none of these inventors anticipated James Watt, the celebrated steam engineer, who not only invented pantagraph machines about 1816, but made them in the most perfect form, capable of the finest work, such as carving medallions.

Mr. George Tangye, manager of the Cornwall Iron Works, of Tangye Brothers, of Birmingham, England, about 1876 leased the old Watt homestead at Fairfield, near Soho, a suburb of Birmingham, and entered into a bond, as a predecessor had done, to preserve the old private workshop of James Watt; so it now stands just as James Watt left it at his death in 1819.

This room remained intact, even to the embers left in the grate and Watt's old pipe lying near, in 1876, when the writer, then residing in England, had the good fortune to be invited by Mr. Tangye to visit Watt's room.

It would be foreign to the present theme to enter upon a description of this room here, further than to say that the pantagraph machines are the most conspicuous of all the hundreds of implements and devices there gathered. It was the last thing that engaged the attention of the great engineer. A full-sized pantagraph, or copying machine, occupies a central position in the room, and on the table of this machine is a partially-completed figure cut from an original of three times the size.

The application of this process to various irregular forms was undoubtedly Watt's intention, and this would have been far less difficult than the processes he had carried out at the time he was suddenly stricken down.

There is a rumour, yet traceable among the people about Soho, that Watt ascertained before his death that the pantagraph, or duplicating, system of operating had been discovered and applied in France; but the author failed to find in the Museum des Arts et Métiers at Paris any account of such an invention,—a fact not at all conclusive, however, because of the lack of classification. Such a lack is astonishing in a French institution, the French people usually leading all others in organization and orderly methods.

From this point the evolution of wood-working machines was shifted from the old to the new world. For a period of thirty years or more but little progress had been made in England in the improvement of wood-working machines,—a matter of surprise when we consider that it was during this time that Whitworth, Bodmer, Nasmyth, Clement, and others produced types of metal-working implements that have been but little improved to the present day.

The development of wood-working machines in the United States, beginning about 1844, was confined to what may be called "finishing" machines, made at Keene, N. H., and at Norwich, Conn., by the progenitors, as they may be called, of the present firms of C. B. Rogers & Co., of Norwich, Conn., and J. A. Fay & Co., of Cincinnati, O. Planing machines for surfacing, matching, and moulding had a nearly contemporaneous development in the Woodworth, Farrar, and Daniels machines.

The American machines were neatly made with wooden frames, and were fitted with an honest care not always emulated at the present day. The makers did their work well; the machines were cheap and suited to the wants of the times and the diffused state of the industry, then carried on in numerous small shops all over the country.

In 1852 the American makers above named, with commendable ambition and in view of foreign trade in their machines, took a number of them to the World's Exhibition at the Crystal Palace in London. These machines attracted much attention. They were operated at a speed far in excess of what was then considered possible or safe in Europe. An idea of the impression they made can be gained from the fact that Sir Joseph Whitworth, then the most famous constructing engineer in England, was commissioned to make a report on them. This report was favorable, and led to an attempt to imitate them, at first by copying and later by substituting iron for wood in their construction, with results that modern practice, on both sides of the Atlantic, will disclose in various designs to be illustrated in future.

About 1860 American makers began turning their attention to iron frames for wood-working machines, and to various improvements which this better and stronger construction permitted. At first the homogeneous nature of metal had not been considered, and the iron in frames was disposed nearly as the wood had been,—that is, in rectangular lines and sections,—and, to further embody the joiner idea of construction, mouldings, panels, beads, and ornate shapes were introduced, as well as decoration by painting and varnishing. These things have lasted almost to the present time, and can be detected now in a good many cases, as they could in metal-working machines at an earlier date.

The evolution of these implements has, however, in function, arrangement, and appearance, or, as we say, in "design," reached an advanced stage, and emulation is now in a great degree confined to workmanship and endurance,—qualities that are at first not so much regarded because inconsistent with change. So long as a machine was liable to be superseded in a few years, its fitting and

endurance were not matters of much concern. The prices for machines have also much increased, and in many cases, especially in Europe, the weight, quality of workmanship, and precision of construction are the same as those bestowed upon metal-working machine-tools.

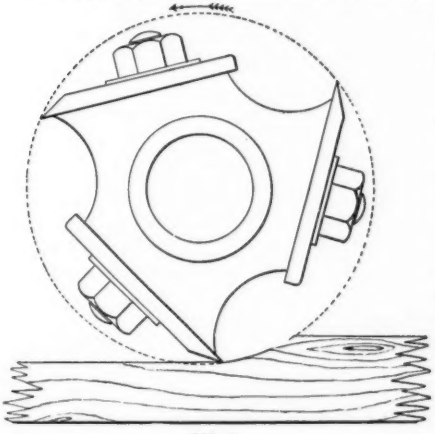


FIG. 9.

A strange circumstance connected with the development of wood-working machines in the United States has been that it did not include in the same degree the principal machines—those for sawing and planing. It stopped with the finishing machines. Planing of joiner work is yet done on an illogical system, not known or practised in any other country, and circular saws are less perfectly mounted and operated, are thicker and more wasteful, and consume more power. The latter is no doubt a result of the cheapness of timber and an economy of labor, but the manner of planing has no explanation that the writer is aware of. The difference in the manner of operating and in results should engage especial attention at this time, in view of a large and increasing export trade in wood-working implements of the finishing class. These differences will be fully considered in connection with the constructive features of the machines; they are mentioned as a feature in the history of the art.

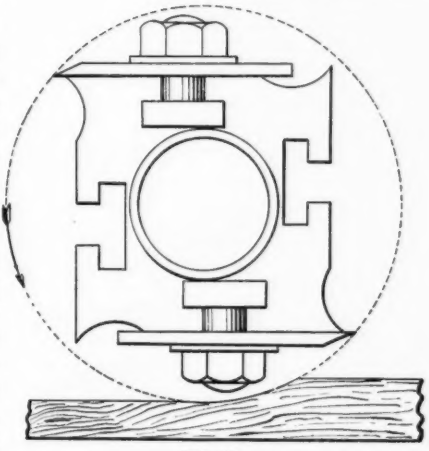


FIG. 10.

Future practice, while it may not be forecast at this time, will

certainly tend to an assimilation of design, by reason of international trade in both machines and timber. Some modifications must naturally result from difference in requirements, the price of timber, and a diversity of uses, but these will only serve to cause a more careful study of the action of machines, and emulation will be confined more to skilled production than to particular modes of operating.

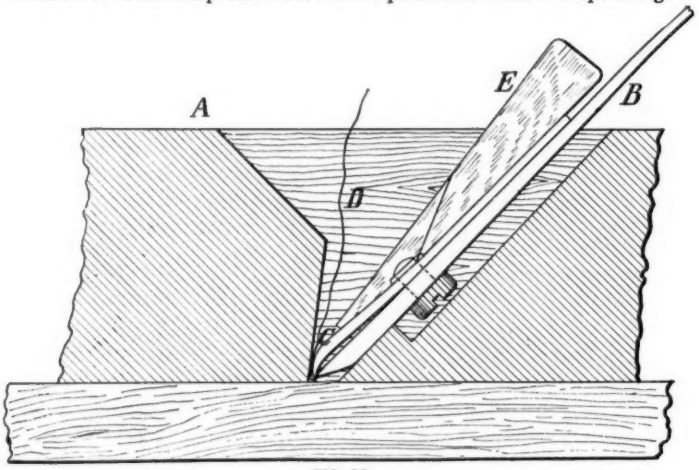


FIG. 11.

Nearly all the operations in wood-conversion are performed by means of cutting edges, but not always under the same conditions. Wood, unlike metals, is of a fibrous or laminated structure, built up of growths, longitudinally, that have but little strength or coherence laterally; and, as cutting must be done each way of the lamination, or grain, as it is called, this divides wood-cutting implements into two classes,—one to operate transversely, or cross-cut, and the other to operate longitudinally. In the operation of saws the longitudinal work is called "ripping."

It may be pointed out that saws, while they form two types of a distinct class of wood-cutting implements, do operate as other kinds, with the difference that saws are to cut narrow channels and are employed to "divide" material, while other implements are employed to "shape" materials. There is also the distinction that saws have usually their cutting edges formed integrally with their supports, or the saw plate, while other implements have detachable cutters.

Two broken sections of straight cross-cutting saws are shown in Fig. 1; also a piece of timber scored with these saws. One of these,

A, has lance teeth, all of one kind, cutting a groove or kerf angular in the bottom, as seen at B. The other saw, C, has pairs of lance teeth, D, to cross-sever the fibre, and chisel teeth, E, that split out the wood, leaving a flat bottom in the kerf, as seen at F. This method is technically called "dado" cutting, and is applied in various modifications to forming grooves and rebates transversely to the fibre.

To further illustrate this cross-cutting process, if one attempts, with any kind of implement, to cut a rectangular notch in a piece of wood, as at G, it is evident that, if the piece cut out is inflexible, there will be no place for the cutting edges at the sides, or shoulders, and the chips will jam. A tool with three sides cannot be used transverse to the fibre, but, if the cut is to be triangular, as shown at H, the fibre is split off by the wedging action of the edges at the sides of the implement, as in chopping with an axe, and is free to rise out of the tool. One of the best illustrations of this method of operating is in cutting angular and square threads on wooden bench screws.

This is illustrated in Figs. 2 and 3. In Fig. 2 a single V tool, A, will cut out the whole channel at one operation, because the chips, B, are free to split off and rise out of the tool as soon as the sides are severed in advance. In cutting the nuts it is better to divide the work between two, or even three, tools of the same shape operating at different depths, but the action is the same. Cutting square threads in screws, as shown in Fig. 4, is a more difficult operation, but is done in the same manner,—that is, the wood is cut away in three triangular sections, as indicated by shading at A and by the notches, B, C, and D, showing the successive stages of removing the wood. These examples illustrate the various operations of cutting wood across the grain; it may be added that the cutters should have a shearing action,—that is, the edges should lean forward and sever the fibre in advance, at the surface.

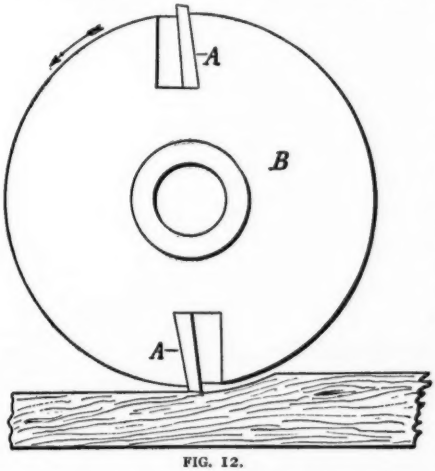


FIG. 12.

Fig. 5 shows an example of longitudinal cutting with rotary knives, producing a slight smoothing cut, the reduction at A being only to make a face. This illustrates in a general way all the operations called planing with rotative cutters to produce planes, as at B, and reduce the wood to a uniform size.

In Fig. 6 is shown an extreme example of reduction at one operation,—a piece of hard walnut wood cut down at B to one twenty-fifth of the depth at C, or from 0.5 to 0.02 inches. This example is from a number of experiments made on the Whitney planing machine, and has been forwarded to the editor of THE ENGINEERING MAGAZINE, lest the statement may be questioned. The principal feature in producing such a result is the general perfection of the machine's action, especially of the pressure bars, E and F, that maintain the reduced section, B, and prevent splintering at C.

In rip-sawing, grooving, mortising, and like operations the lateral separation of the fibre is not performed directly by the edges. It is torn or pressed off by force, and is not cut. For example, Figs. 7 and 8 show side and end views of a piece of timber having a groove or kerf, A, cut out by a circular rip-saw, B. By comparing with Figs. 5 and 6, it will be seen that the operation is just the same, except that the shavings have to be split off at their edges, which amounts to little in this case, because of their thinness. The saw, B, has teeth that are plain cutters of chisel form, acting successively, each cutting out a shaving as a planing knife does.

Fig. 9 shows a planing head,—commonly called, when long, a "cylinder,"—arranged for three knives, and Fig. 10 a moulding head to receive two or four cutters, not drawn from special examples, but to show in general the manner of mounting and supporting cutting implements for operating longitudinally.

Another expedient in wood-cutting is the means employed to prevent "pulling out," or splintering, when operating on cross-grained, knotty, or burl timber.* These expedients include three different means,—namely, the use of caps or back-irons, the selection of the angle at which the knives act, and the adoption of scraping cutters. These methods are illustrated in Figs. 11, 12, and 13. The first, being a cap, or back-iron, as applied in hand-planing, also corresponds to the lips, or guard irons, D, in Fig. 6, which act in the same manner. A is the plane stock, B the iron or knife, C the cap, D a shaving being cut off, and E the wedge to hold the plane iron. The cap, C, is fitted at its edge with great nicety, so as to expose a

* The term timber is used, because it is the generic name from the old Saxon "Timmer." "Lumber" is an old and useful name, meaning waste or cumbrous material of any kind. There is no warrant, except local use, for applying it to sawn timber.

mere line of edge when the work is fine. The shaving is, by the cap, C, crimped, or doubled back so as to press down and hold the wood in advance of the edge, that it may not splinter or rise. Only a very skilled workman can fit up a plane that will operate on veneers, or on cross-grained, or crotch-wood. In machine cutters, or knives, such caps, or back-irons, are less important, and are seldom fitted as accurately as in hand planes.

In Fig. 12 a like result is obtained by the angle of the cutters, A, which are set almost radial on their faces, have thick blunt edges, and

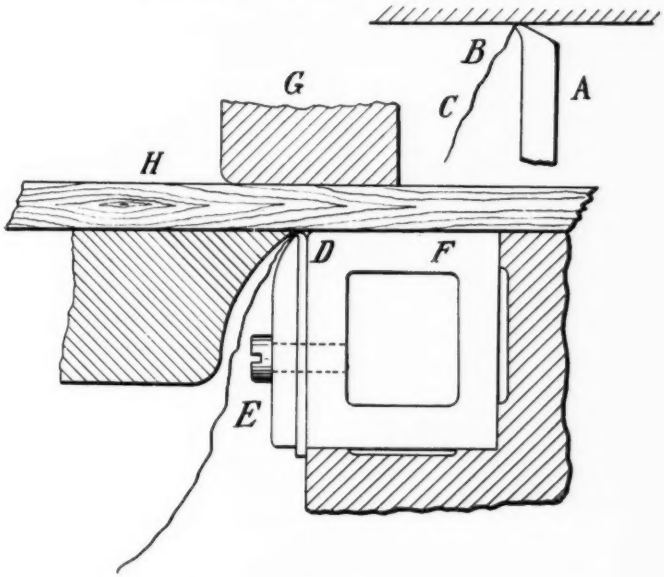


FIG. 13.

are made extremely hard. They operate exceedingly well on all kinds of hard wood, such as banyan, boxwood, rosewood, cocoa, and especially lignum vitae and teak. The last-named, a most obdurate material, is said to contain silica in its pores. Such cutters also work well on ash, oak, hickory, beech, or any hard wood. The heads, B, are commonly made of wrought iron or steel, the cutters being keyed in so as to be supported close out to their edge, and also for safety, because it is convenient to work at double the ordinary speed with one cutter. The writer, who, thirty years ago, when engaged in this line of work, made a good many machines to operate in this manner, much wonders

that the method has not spread more. The system, in the form shown, was invented or introduced by Mr. J. A. Montgomery, of Columbus, O., about 1855.

The third method—that of the scraper shown in Fig. 13, commonly known in the form of a piece of broken glass—acts like the cutter in Fig. 12, but with a corner having an angle of 90 degrees. The diagram at A is an enlarged section, showing a machine-scraper, sometimes made to cut a clean shaving across a surface 36 inches wide and of any length. The edge, B, is turned by a machine, and is much more perfect than the edges made on hand-scrapers used by cabinet-makers. The shaving cut off is broken or crimped as soon as severed, but on tough wood comes off in a complete sheet, except that it is shortened to a third or half the length of the board from which it is cut. Knots and all kinds of cross-grained wood are cut in the same way, and left with a smooth surface. These machines will be noticed again. The main figure shows the method of mounting these scrapers in a machine. D is the knife, E a cap, F a draw frame carefully fitted across the machine, G a pressure bar, and H the timber being planed.

There are a number of other features—or "principles," as they are called—relating to the action of cutters; these will come up in connection with certain machines, or classes of machines, to be hereafter considered. It will appear that all the various operations in wood-cutting are embraced in these two processes,—namely, scoring or cross-severing the fibre, and cleaving edges that split and shave longitudinally; also that the functions of wood-cutting machines are to hold and impel cutters, and to support and present the material.

THE MINERAL RESOURCES OF CUBA.

By Jennings S. Cox, Jr.

IF we listen to the voice of the charmer, or go to the books on Cuba for our information, we shall find that the mineral resources of this island include gold, silver, mercury, lead, antimony, copper, chrome, iron, manganese, pitch, bitumen, and even coal; but when we look for practical metallic results commensurate with these varied mineral resources we shall be disappointed.

The gold fiction is the most time-honored, for the original Spanish settlers expected to find rich gold mines in Cuba. According to their historians "much gold was taken from this island at the beginning of the conquest," but it seems probable that most of this was taken from the chiefs, or caciques, of the Indians and very little from the ground. "El Viagero Universal," Madrid, 1797, says: "some of this metal (gold) is still found at Holguin." Whenever the existence of gold in Cuba is discussed this "mine" at Holguin is invariably brought forward. It is true that some work has been done at this point and a little gold has been extracted, but there has never been any systematic exploration, and there is nothing there which may be dignified with the name of a mine.

In like manner most of these mineral resources fade away in the search light of investigation, until only copper, iron, and manganese remain. Of most of the others listed above, it is fair and proper to say that they have been found but are not worked. It may fairly be doubted if mercury and coal have ever been found, although "denunciations" of mercury exist.

Copper occurs frequently, in greater or less quantities, in the metamorphic rocks which form a large portion of the island of Cuba. The principal occurrence is as chalcopyrite, in quartz veins in the metamorphic rock, at the village of Cobre, in the mountains about twelve miles west of the city of Santiago de Cuba. The mines at this point were discovered some three hundred years ago and were worked to a limited extent, but always as crown possessions or under royalties to the crown. They were abandoned and had been idle for more than a century when, in 1830, an English company reopened them and worked them systematically and actively, employing as many as 2000 men. A railroad was built from the mines to Santiago bay. The remains of this road still exist.

The railroad was owned by a Spanish corporation, and the mines and railroad became involved in litigation. The railroad company

won its suit but "killed the goose that lay the golden egg," for the excessive freight charged by the railroad, the reduced price of copper, the scarcity of labor, and the breaking out of the ten years war combined to close the mines once more.

The extensive plant of the English company—which included what was, in its time, the largest Cornish pump in the world—their crushing and concentrating machinery and buildings, are now nothing but a picturesque heap of ruins.

There is no available record of what these mines have produced, but the deepest shafts were 900 to 1000 feet deep and the underground workings are said to have been very extensive.

To-day cement copper is made in a small way by precipitating in

VIEW SOUTHWARD FROM LOLA MINES, LOOKING OUT TO DAIQUIRI BAY.

tanks, by means of scrap iron, the copper held in solution in the water that seeps through and drains from the old waste dumps and in the water that fills the shafts. The amount of copper produced in this manner is, however, insignificant.

MANGANESE MINES.

There are a number of manganese mines in the province, mostly to the west of Santiago de Cuba, which have been worked in a desultory way, the lack of proper transportation facilities making it impossible to operate on any considerable scale, although the ore is very high grade. The Ponupo Mining Company, an American corporation, has built a branch of the Sabanilla y Moroto railway into its mines and, although prevented from working during the Spanish-Cuban war, is now opening its mines and preparing to ship extensively.

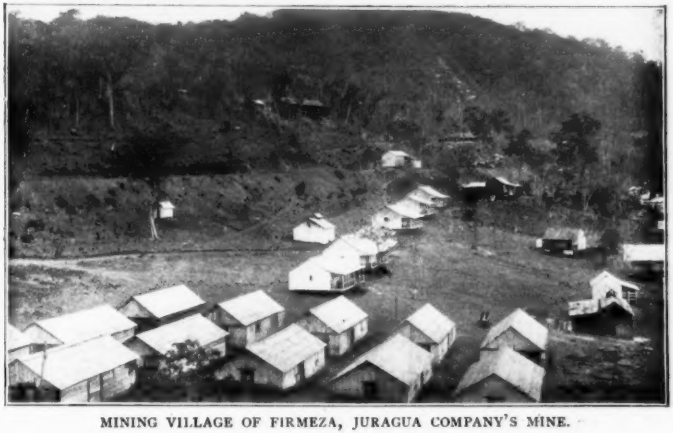
AN OUTCROP OF THE SAN ANTONIO ORE-BODY.

IRON ORE DEPOSITS.

The coast range of the island of Cuba near Santiago de Cuba, generally known as the Sierra Maestre, is rich in hematite and specular iron ores.

While it is not within the purpose or scope of this article to discuss in detail the geology of the country, or the genesis of these ore bodies, these may be briefly indicated.

This portion of the island is the result of successive upheavals. The coralline limestone rests on syenite ; this syenite has been over-

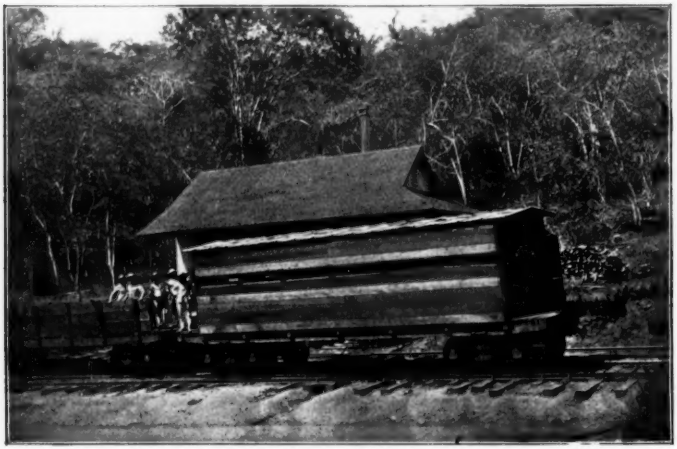


MINING VILLAGE OF FIRMEZA, JURAGUA COMPANY'S MINE.

HOUSES OF MINE OFFICIALS AT VINENT.

flowed by an immense mass of highly basic ferruginous trap, which has made its way to the surface in numerous dykes.

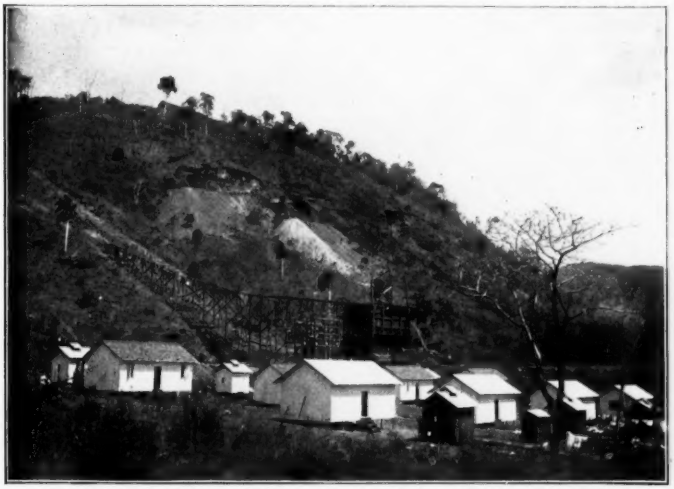
From this trap the ore bodies of the district have been formed. Great quantities of ferric oxide have been dissolved out by the action of surface waters, from which they have been re-deposited in concentrated form. In many, probably in most, cases the ore bodies are the result of the weathering of isolated bodies of coralline, and their replacement by ferric oxide from the percolating waters. For this



ARMORED CAR IN COMMISSION ON THE RAILWAY. MARCH, 1897.

reason they are without definite walls or regularity of arrangement. They are scattered along the range of hills for a distance of eighteen or twenty miles, but there is no continuity of formation.

The region where these deposits exist was formerly occupied by the plantations of wealthy Spaniards. Everywhere in these beautiful hills can still be seen the remains of the fine roads, shaded by bamboo hedges, over which the proprietors passed in their *volantes*. One of these roads passed through the ore body that is now the Magdalena mine, and was known as the "black road" because it was practically pulverized iron ore. These rich old grandees must have known, but



TRACK DEPOSITS AND INCLINE. SAN ANTONIO MINE IN THE CENTER.

apparently did not realize, what lay at their feet, and it was actually not until the year 1861 that the first claim was located, or "denounced." Since then more than two hundred locations have been denounced in the Sierra Maestre, both to the east and west of the city of Santiago de Cuba.

Of these denouncements, the most important and, in fact, the only ones that have ever been worked are to the east of the city, covering a distance of twenty odd miles along the range a few miles in from the coast. As has been stated, the deposit is not continuous, but there are numerous separate deposits along the distance, some of them being very extensive.

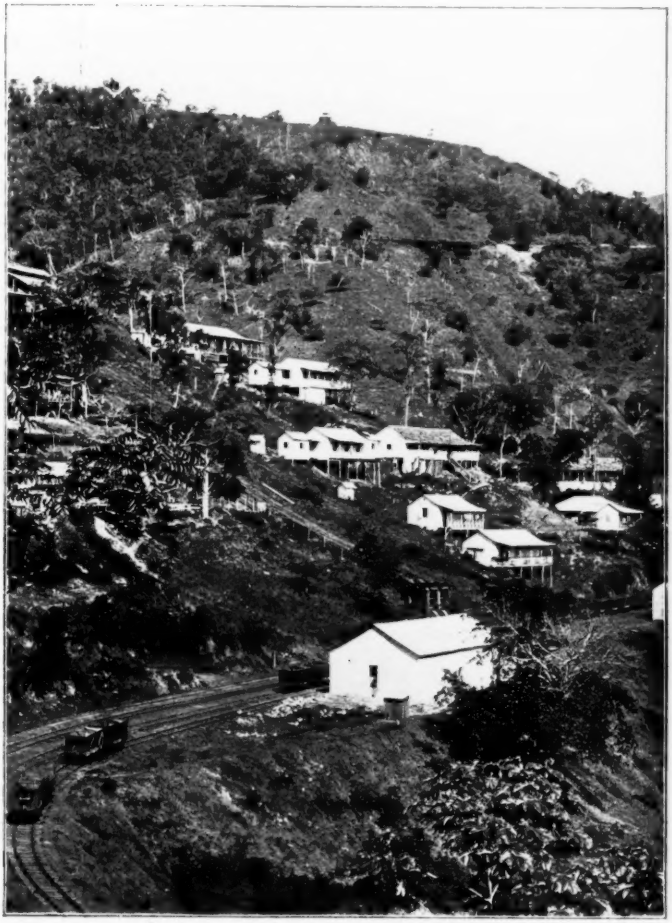
In order to encourage the mining of this ore, the crown of Spain

issued on the 17th of April, 1883, a royal decree to the following effect: That for a period of twenty years from that date, the mining companies should be free from all tax on the surface area of all claims of iron or combustibles; that ores of all classes should be free from all export taxes; that coal brought in by mining companies for use in their work should be free from all import duties; that combustibles as well as iron ore, should be exempted, from the 3 per cent. tax on raw materials; that mining and metallurgical companies should be free from all other impost; that, for a period of five years, the mining companies should be exempt from the payment of duties on all machinery or materials required for working and transporting the ores; that vessels entering in ballast and sailing with ore should pay a duty of five cents per ton navigation dues, and that vessels entering with cargo destined for the mining companies should pay $1.30 per ton navigation and port dues on all such cargo, and on the remainder of the cargo as per general tariff.

Encouraged by the liberalty of this royal decree, the Juragua Iron Company, Ld., a Pennsylvania corporation which had secured by purchase and leasehold a valuable group of mines, at once commenced the construction of a railroad twenty miles long, from their mines at Firmeza to Santiago Harbor, where they built an ore dock and, by remarkable activity and energy, succeeded in shipping their first cargo of iron ore in 1884. The success of this enterprise caused every one who owned a "denunciation" or claim anywhere along the range to "mark it up," and the price of claims and lands rose greatly; but no new investors appeared for several years.

Mr. Samuel P. Ely, of Cleveland, Ohio, purchased in 1889 the

HARBOR OF SANTIAGO, AND PIER OF THE JURAGUA IRON CO.



VILLAGE OF FIRMEZA, AND JURAGUA COMPANY'S MINES.

mines known as the Lola group and organized the Spanish-American Iron Company. These mines are several miles to the east of the Juragua group and no attempt was made to connect them with Santiago. A railroad was built directly to Daiquiri bay, an open roadstead on the Caribbean sea. Here a considerable engineering problem presented itself in the question of a proper shipping pier or dock.

It was proposed to build a breakwater and sink wooden caissons, filling them with concrete to form piers for an ore dock. A caisson 30 ft. in diameter was gradually sunk to a depth of about 30 feet in sand, when it rested on large boulders and could not be sunk further.

The work of filling in the concrete was begun, but on the same day a great storm arose and in a few hours every vestige of more than a year's work was carried away. This project, including the breakwater, was then abandoned.

It is characteristic of engineering science that its failures are but stepping stones to success; work was immediately begun on a new dock. This time ten iron cylinders, ten feet in diameter, were sunk to bed rock and filled with concrete. The cylinders were arranged

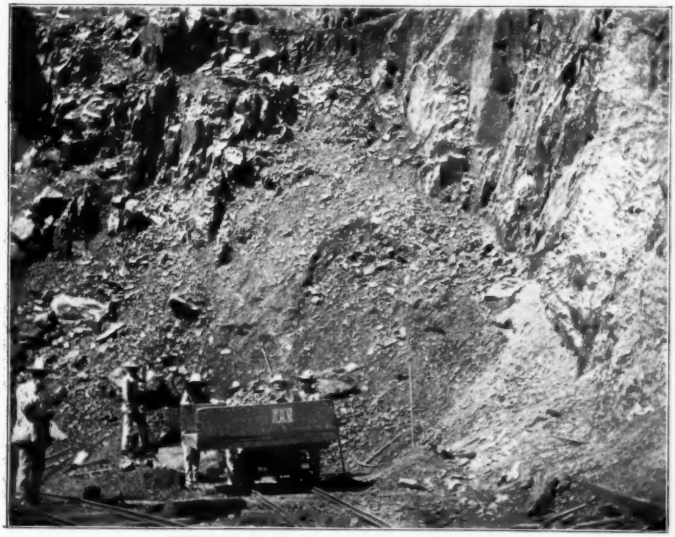
THE ORE DOCK AT DAIQUIRI.

in pairs, twenty feet centers, the pairs about 67 ft. apart. Four pairs support a steel ore dock, similar to those in use in Lake Superior, and the fifth pair forms the pier of the bridge approach. The dock is a substantial monument of engineering skill and has thus far withstood the severest storms.

Various delays retarded the work of this company, and it was not until May, 1895, that the first cargo was shipped.

A third American company, The Sigua Iron Company, had meanwhile purchased a large tract of land and numerous claims some miles east of the Lola group, and at Sigua Bay, more sheltered than Daiquiri Bay, a breakwater was built and a wooden ore dock was erected. This was connected with the mines by a railroad nearly nine miles long. Some two millions of dollars were expended here and 12,000

THE LOLA MINE.

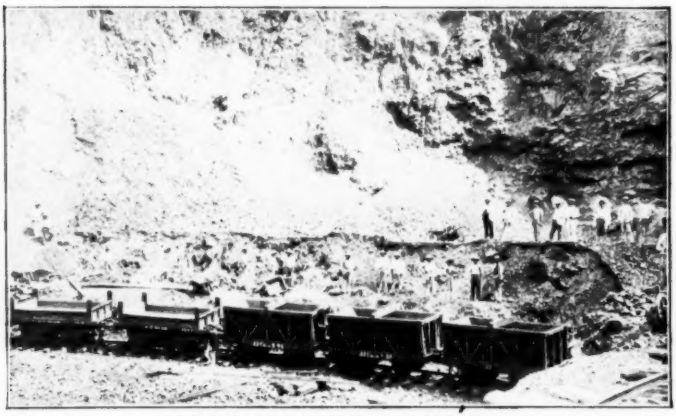


WORKING FACE OF ORE BODY, LOLA MINE.

DAIQUIRI MINES.

tons of ore were shipped when all work was stopped for lack of ore. The mines were in a watchman's care during the insurrection, but at Sigua bay the docks, shop, and buildings were all destroyed; the railroad embankments in many places have been carried away by the floods and only the wreck of these extensive works remains.

The Spanish-American Iron Company and The Juragua Iron Company remained in operation during the entire war between Spain and Cuba, and, although located on the extreme outpost of the Spanish troops, and with Cuban forces in the immediate vicinity, maintained throughout a strict neutrality, and continued shipping ore until they



WORKING FACE IN THE JURAGUA MINES.

were closed by order of the Spanish authorities after the declaration of war between the United States and Spain.

The three iron companies mentioned, which are the only ones that have ever operated mines in the province, represent an investment of American capital of about $8,000,000.00, and the two still operating have paid into the treasury of the United States more than $2,000,000.00 in import duties on iron ore.

The following table shows the production of iron ore in the province from 1884 to 1897.

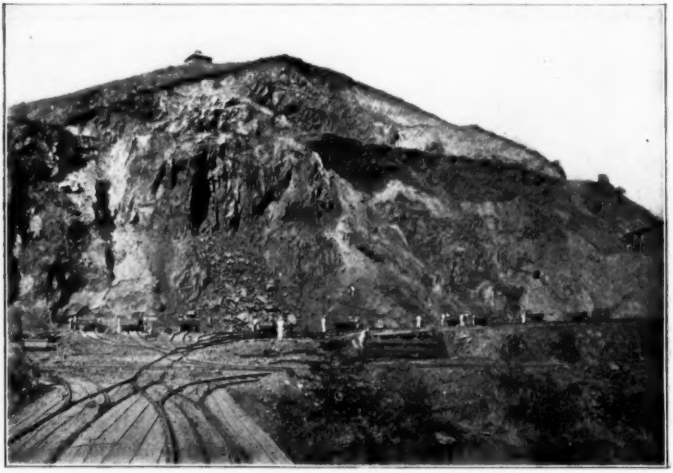
	Juragua.	S. A. I. Co.	Sigua.	Total.
1884	23,977	.....	.....	23,977
1885	80,095	.....	.....	80,095
1886	110,880	.....	.....	110,880
1887	94,810	.....	.....	4,810
1888	204,475	.....	.....	204,475
1889	255,406	.....	.....	255,406
1890	356,060	.....	.....	356,060
1891	261,620	.....	.....	261,620
1892	320,859	.....	.....	320,859
1893	334,341	.....	12,000	346,341
1894	153,650	.....	.....	153,650
1895	302,050	74,991	.....	377,041
1896	291,561	114,110	.....	405,671
1897	246,530	206,029	.....	452,559
Total	3,036,314	395,130	12,000	3,443,444

SAN ANTONIO MINE AND OFFICE.

The ore is found in isolated bodies without definite walls, and generally near the tops of a range of hills, two and a half to four miles directly back from the coast. There is no underground mining and, happily therefore, no necessity for timber. All mining is in the nature of open cuts, or quarrying, the ore being taken out in benches, some as much as 100 feet high. In the view of the writer, benches of 50 feet, such as are employed in certain of the mines, represent the best practice as the presence of pockets of dirt in the ore makes it apt to fall, and therefore dangerous to work in high benches. The ore, although fissured and broken, is intensely hard and, after being turned over in large masses, must be blockholed and sledged.

After loading in mine cars the ore is never again handled. It is dumped into pockets, and from these lowered by gravity inclines to the main line of the railroad. Hopper dump-cars take it to the docks, where it is either dumped directly from ore car to vessel, or into storage pockets on the dock whence it runs by chutes into the hold.

The ore is mainly an amorphous hematite, with occurrences of specular ore and a quantity of magnetic oxide. It is of high quality, being rich in iron and low in phosphorus. Average analyses of 206,029 tons of Spanish-American iron ore show the following: iron, 63.1 per cent.; manganese, .097 per cent.; copper, .056 per cent.; sulphur, .072 per cent.; phosphorus, .029 per cent.; alumina, .712 per cent.; lime, 1.06 per cent.; magnesia, .381 per cent.; silica, 7.225 per cent.



THE LOLA MINE.

The light streak about midheight on the right-hand side is a stratum of dirt.

DAIQUIRI, FROM THE WATER.

Such, in brief, is the history of iron mining in the island of Cuba. What the future of the industry may be, it is difficult to say. It is notable that, although the two companies have continued in operation for several years, no new companies have started. The reasons are not far to seek. When the Juragua Iron Co. first began shipping, iron ore was worth $6.50, or more, per ton in the open market; today ore, even of the excellent quality shown in these analyses, will not bring half that amount. The present companies, with their capital invested in equipment, railroads, docks, and harbor improvements, must continue; but there is no temptation to capital to develop new mines. Any new opening necessitates a railroad, a dock, and harbor facilities; and there is nothing but a more than problematical profit on an unknown quantity of ore to invite to the investment. Moreover, there is another question, the most serious of all—the one of which the capitalist often fails to think on entering a new country, though he pays for this by thinking of nothing else after he enters—the question of labor. There has never been an adequate supply of labor since the mines were opened in Cuba. Tens of thousands of dollars have been spent to recruit the supply, and the cry is always for more. Once the Spanish government loaned soldiers for miners, and this was the brief golden era for the mines.

Since the war between the United States and Spain the question is even further from solution. One has not the whole labor world to draw on, because the northern laborer cannot stand the intense heat, succumbs to fever, and soon becomes useless. Even the Italian falls a victim to the fever. The native Cuban will not work in the mines if he can find anything to do in the fields and, as soon as the sugar estates start grinding, it is a foregone conclusion that the Cubans desert the mines for the fields.

The one man who can work in the Cuban iron mines is the Spaniard of Galicia, trained to this work in the mines of Spain. For him the heat has no terrors. He gets the fever and recovers and returns to his work. At his best he is sober, industrious, and saving;

THE ORE DOCK AT DAIQUIRI IN COURSE OF CONSTRUCTION.

but his name is not legion and, since the war has driven him home, the lack of labor has become so serious as to menace the future of the whole iron industry in the island.

Much has been written from time to time of Cuba's wealth of iron. These points will possibly make clear why there has not been more development of this wealth. Setting aside the present uncertainty and lack of stable government, it is reasonable that capital should not seek investment where so much preliminary outlay must be made for railroad equipment, shipping arrangements, and the like, when ore is at a price which offers no inducements, when a 40-cent per ton duty rules against the ore, and when the very basis of all mining, "the tin-bucket brigade," is conspicuous by its absence.

AMERICA AND GERMANY AS EXPORT COMPETITORS AND CUSTOMERS.

By Louis J. Magee.

I.—NATIONAL RECOGNITION OF THE IMPORTANCE OF INDUSTRIAL EXPORTS.

DESPITE the watchword "America for the Americans" and a national tendency to adjust questions of import tariffs, commercial treaties, and territorial possessions independently of the ideas of other dwellers on the earth, every reader of THE ENGINEERING MAGAZINE at least must have been thinking with deep concern that the United States are not independent of other nations, and cannot afford to shape their policy without regard to its effect on their neighbors. To those who follow with anxious eyes the success of the great industrial army abroad, watching for the effect of the weapons of trade in the international struggle, the cry of "America for the Americans," with all that it means, sounds almost ironical. Those whose factory wheels would cease to turn but for foreign orders must surely feel that the United States have not for a long time past, commercially at least, been pursuing a policy of isolation. American capitalists and industrial organizers, agents, and experts who are using the influence of their country's representatives in foreign cities and employing every argument of technical excellence, giving every possible financial concession, straining every nerve to interest, please, convince, and gain the confidence of a new clientèle abroad, must sometimes wonder that their countrymen, as a people, can be so self-confident and indifferent to the friendship of other nations. Speaking of the international isolation of the United States, Richard Olney says: "The commercial isolation of a great power denotes its conviction that in matters of trade and commerce it is sufficient unto itself, and need ask nothing of the world beyond. In the case of the United States the policy of political seclusion has been intensified by a somewhat prevalent theory that we are a sort of chosen people; possessed of superior qualities, natural and acquired; rejoicing in superior institutions and superior ideals; and bound to be careful how we connect ourselves with other nations, lest we get contaminated and deteriorate.*

Coincident with the national self-examination which has been going on for some months, the critical weighing of world-interests, and the discussion of a future policy among nations, the question of America's place in the markets of the world, and in the great engi-

* *Atlantic Monthly*, May, 1898.

neering enterprises, is also brought urgently to the front. But not only in the older markets has America suddenly found itself face to face with grave questions of trade. The probable opening of China to modern influences, and the achievement of the Trans-Siberian railroad, also cause one to ponder as to America's share in the development of these vast empires; and finally come the problems of organizing trade in territories where a preponderant influence has been recently acquired. "New issues and vastly larger fields of action have been opened. Three years ago we felt that our international issues—so far as they existed—had little relation to the great world's worry. To-day we are, for good or bad, in the midst of it all. Intercommunication and rapid transit have been steadily drawing the ends of the earth together. Silent mighty forces have long been assembling to the melting-pot the stubborn forms and patterns of the older world. Suddenly the fire is lighted." *

The industrial elements in the United States know, in fact, perfectly well that they have fully emerged from anything like a policy of isolation, and that they are struggling with a new energy for opportunity to supply a good share of the world's mechanical necessities. It behooves the industrial elements, then, to work toward a broad recognition, on the part of the government, of the value, the very necessity, of export trade. They should make themselves felt, not in their demands for protection of the home market,—a protection which they no longer need,—but for the business-like regulation of foreign relations. Well-studied, comprehensive commercial treaties should be their aim, guaranteeing a certain term of unalterable trade relations, free from the caprice of domestic political parties, and protecting American and foreign exporters alike from the anxiety, the insecurity, that comes when great nations want to trade with each other and still cannot quite decide where to drop chicanery.

Bismarck said in the reichstag in 1885: "The most important element of our industries is manufacture for export. Let our export trade once become unable to compete with that of foreign countries, and our whole industry will suffer." The United States should recognize this as a government and as a people. The careful following up of the nation's interests in the detailed questions which directly affect exporters themselves is a *sine qua non*, if the central government is to seek advantages of its people's trade, open up new markets, or even keep exporters protected and uphold their efforts in those countries to which they have found their way alone.

The methods adopted by a great industrial nation like England, Germany, or America may not all be applicable to another country,

* Benj. Ide Wheeler, *Atlantic Monthly*, August, 1898.

but would certainly repay careful study—a study sure to engender mutual respect and appreciation among these mighty neighbors. At the same time that foreign nations appear to some branches of the industry in the light of competitors, they are to others perhaps only customers, and therein lies the short-sightedness of hard feeling and retaliation, and the reasonableness of a friendly and conciliatory attitude between the great industrial peoples. The study of trade questions should be distinctly separated from party politics, and should be in the hands of experts permanently in office. No great firm can work to advantage without trained heads, experienced organizers, and experts with detailed knowledge; nor can a government support or protect its industries without an intimate acquaintance with their aims and difficulties. We have probably all thought, as we have wondered at the daily work of one of our great industrial leaders as he sits like a spider in his web where all the lines converge, that the country would be fortunate to have such business experience, system, and energy in that high place where the very qualities that make an industry great seem also to be so necessary.

Though not in the line of manufacturing industries, the case of the San José Scale is a good illustration of how a central government, by keeping itself informed, can protect vast commercial interests. Germany forbids the importation of all American nursery stock, or fresh fruit which is affected with living scale, protecting thereby its own horticultural interests from the disaster which has befallen the fruit growers of the United States. That the Agrarian influences at work in Germany caused the government to go too far in this matter, as well as in prohibitive measures against meat and cattle, is declared by liberal Germans to be the case, but this does not affect the value of the action in general. Germany was the first foreign government to obtain exact information on this subject, and her course has been followed by Canada, Austria, Holland, and other foreign countries. She had a scientist of ability at Washington, who kept himself as well posted as the department officials there. The United States might, with advantage, have made similar studies under diplomatic protection in foreign countries, for the majority of the principal American insect pests are of foreign origin.* The recent agricultural attaché at Berlin is of acknowledged high standing, and it was hoped that his position would be permanent. In general, however, the United States government seems to have little realization of the importance of having commercial or scientific experts to study conditions abroad. While the information gained by such experts would be largely confined to that which is publicly known in the countries where they are stationed

* *Forum*, July, 1898, page 573.

and—through the press—open to the world, the relative importance of the methods and lines of development would be appreciated in a way that only personal contact can make possible. Just as misunderstandings of the gravest character come between business firms whose correspondence is most carefully attended to, and have to be adjusted by personal interviews, so the commercial relations of great industrial countries—enormous and complicated as they are bound to become in the future—will be much more fairly adjusted, if the statesmen have a large basis of expert advice to work upon. A thorough master of his own trade or industry stationed in a foreign centre of activity, reporting to a liberal-minded, well-informed superior at home, would, in all probability, be able to send information the value of which to the commonwealth would easily outweigh the expenses of a whole embassy. England and Germany set a most instructive example in this direction.

The German consular service is being strengthened. Additional secretaries are to be appointed to several of the most important legations and embassies. Experts in agriculture and forestry are to be attached to the embassy in St. Petersburg. Commercial experts are proposed for service in the United States, South America, and Turkey. The London *Daily News*, in taking note of this activity, says: "It proves once more with what keen attention the German foreign office is watching and supporting German trade abroad. It is all done without fuss, and with the command of very poor means. . . . The German government, without neglecting agriculture at home, is making commercial interests more and more the basis of its foreign policy. German export trade forms the centre of gravity of almost every political transaction."

The German ministry of commerce, which has regulated the question of unfair methods of trade competition at home, has also cautioned German exporters against using methods or publishing statements in any way derogatory to articles of foreign make. Only recently the consuls have been especially requested to report regarding alleged statements deprecatory of certain English products. This certainly evinces a desire for fair play on the part of a government which does all it can to help its own people in their extension of trade. It is rather a high-minded policy, when one remembers how "Made in Germany" has been the watchword of an English crusade against German wares.

Another illustration of government aid to industries is to be seen in the reduced inland freight rate granted some years ago by German railways for articles *en route* to Spain. Of course, in the United States, such a reduction seems at present impossible, or exceedingly

difficult to arrange. Apropos of this subject, a leader in the German financial world, when asked if he thought the United States government ought to control the railways, said: "A system which works well here (which indeed has given railways to poorer districts, where the traffic is too small to invite private capital) would not necessarily prove successful in other countries. In Germany our good organization is a natural consequence of our military system. A country like the United States, which is not accustomed to a similar strictness of organization and a well-ordered civil service comparatively independent of party politics and changes in the administration, may accomplish much greater things than we, but cannot without danger place its railways under government control."

It was a cause of great satisfaction when the emperor recently, on the occasion of his decennial celebration, created the representatives of three Prussian technical institutes members of the Prussian house of lords for life, "in recognition" (as William II said in a telegram which Professor Slaby—one of the three—read to his students after the daily lecture on electricity) "of the important place which engineering has assumed at the close of this century." The emperor has often attended Professor Slaby's lectures and watched experiments in the electrical laboratory. In general, the emperor's interest and appreciation is a permanent encouragement for men whose only ticket to court is brains. A retired captain and navy-yard director says that the emperor's observations on ship-building and armament show an astonishing grasp of the subject.

The government offices are easy of access. The officials, if sometimes afraid to take too much responsibility and overrun their competence, are always well informed in their special lines, appreciative of suggestions, and open to offers for improved methods, always ready to examine any means of helping German trade and follow up any alleged infringement on the privileges of Germans in the open market; and they are free from the suspicion of corruptibility.

The various departments of the government have on their lists officials who act only when called upon; professional men of all branches, teachers, manufacturers, and physicians, whose whole activity could not be paid for by the government, but who serve on committees or give written advice on the more important matters from time to time. For instance, the patent office puts important disputed cases into the hands of special committees, which sometimes include the highest obtainable authorities. In the State as well as the municipal service one continually comes upon this system of temporarily calling in experienced men, whom the government could not afford to monopolize, to give a portion of their wisdom for the public

good. The unpaid officials of Berlin's city government make a list as large as the Berlin telephone directory. These men serve on the committees for almshouses, hospitals, parks, bathing establishments, etc., each giving gratuitously for the public good at least a deal of time, and frequently professional experience and expert knowledge. One of the medical authorities of Europe, a man whose clinic is a great favorite with American students, considers it an honor to serve on the committee of public baths for Berlin. The public performance of public duty, free of the acceptance of public money, is perhaps still more prevalent even in wealthy England. The marquis of Lorne referred to this characteristic of his country as "a case for free imports" into the United States. He quoted the late Lord Bramwell as saying at a public dinner, in reference to the work of a colleague, "he labored as only men do in this country (England) when they receive no pay."

In the extension of educational opportunities the German government is continually directing its attention to the intellectual betterment of the artisan and tradesman with regard to the promotion of foreign trade. There is great activity at present in the improvement of educational methods and facilities, especially in so far as they have a direct effect on industry. A new high school, for instance, for the teaching of "commercial science" has just been established by the government at Aix-la-Chapelle. This institute will be a valuable adjunct to the government technical institute in the same city. The plan of study includes a number of courses in various branches of economics and the commercial side of the industries. It is also proposed to increase and further develop commercial so-called continuation schools, and industrial schools for boys and girls. More complete workshops are to be established for learners, to replace or supplement the present system of apprenticeship. In connection with this reform, permanent exhibitions of first-class machinery and tools will be organized, as well as associations for workmen and shopkeepers.

In Berlin most varied opportunities are offered for systematic study of the trades and for the pursuit of common school branches in night schools especially established for wage-earners. The city maintains alone two school for artisans, where apprentices have instruction in drawing, decorative painting, mathematics, physics, chemistry, etc., including classes in the installation of electric plants, especially for wiring men. In these two schools there are more than three thousand students and more than one hundred teachers. Then the city has a school for masons, and one for carpenters and cabinet-makers. Furthermore, the city and State divide the expenses of another important school,—namely, a school for the training of workmen in architect-

ural building; and, finally, a school for the textile industry. Ample opportunity is provided in most of these schools for the learning of English and French. Among other important industrial institutions in Berlin should be mentioned those founded by the guilds of most of the trades. Besides what the guilds contribute, the city and the State help to support these schools, the city providing in all cases the necessary room, light, and heat. From 10 to 50 per cent. of the cost of maintenance comes from the contributions of the students.

The "Urania" in Berlin, a people's physical laboratory connected with a "Scientific Theater" (where lectures illustrated by lantern slides and scientific apparatus are given), is an institution which out-yankeefies the Yankees for ingenuity. By paying twelve cents the poor student can go in and spend his evening in the laboratory, and perform each experiment in physics by simply "pressing the button." Germany is behind America in public libraries and reading rooms,—an advantage for which the United States has to thank private generosity rather than the commonwealth.

The technical high schools—*i. e.*, institutes of technology—are overcrowded. In the eight institutions of this class in Germany there are ten thousand students taking the courses or hearing some lectures, and of these fully one-half are studying mechanical, electrical, or marine engineering. Engineering societies have called the attention of the government to the need of more technical high schools, the desirability of making the conditions of entrance more severe, and the creation of technical middle schools to prepare students directly for the high schools. Probably American technical schools, in their methods as well as their equipment, compare favorably, to say the least, with those of Germany. Germany, however, deserves great credit for her pioneer work in technical education in the years when there was much less applied science to teach and much less national wealth to provide the schools and museums. Years ago, the present ambassador of the United States at Berlin, Andrew D. White, impressed by what he found in Germany, strongly advocated in America the introduction of veterinary, agricultural, and forestry schools, and thus the United States may be, for a good many of their splendid modern institutions, directly thankful for lessons taken (though but slowly) from Germany.

In connection with education, an interesting experience was recently related by the manager of one of the best known steamship companies. A large liner, bound homeward from South America with a heavy cargo and several hundred passengers, was laid up at one of the island ports of the west coast of Africa by an extraordinary accident to the engine. A telegram came, demanding another

steamer, as speedy repairs were impossible. After a lively interchange of messages, the home management was about to send out a reserve. At this juncture a German engineer of considerable theoretical knowledge, but without experience in marine engines, happening to be in the port, heard of the trouble, asked permission to examine the engine, and suggested a remedy, and the disabled ship proceeded homeward. The steamship company profited by this experience. It had learned that knowledge picked up in the practical experience of any one individual is insufficient to cope with all that may happen. It decided upon giving its engineers more theoretical training, and ordered a number off at half pay for two years' study. This course has become so popular that more men than it can spare from active service have applied for permission to study at half pay, although their full pay is low.

Naturally the same logical organization that is so praiseworthy in domestic affairs is bound to tell for the Germans in their efforts abroad. Their governmental methods deserve the deepest study on the part of a people like the Americans, possessed of unsurpassed courage, shrewdness, energy, and intense practicalness, combined with a love of liberty which sometimes amounts almost to disorder.

THE TALL BUILDING UNDER TEST OF FIRE.

By H. de B. Parsons.

THE modern "sky-scraper" presents many problems, but none more generally interesting than the question of its security against fire. The picture below shows the result of the careless dropping of a lighted match. The photograph presents the ruins of the Burdette Block, in Troy, N. Y., which was wrecked by fire on February 17, 1896. The building was erected in the ordinary manner, with brick walls and wooden floors. So rapidly was it consumed that four lives were lost, although the fire took place in the day-time. Buildings of this class are totally unable to resist fire.

Many imagine that, because iron and steel are incombustible (in the common acceptation of the word), buildings constructed of such material, together with bricks, cement, and glass, may be classified as fire-proof. The construction of a building out of materials in themselves non-combustible does not produce a fire-proof structure. Fig. 2 represents the ruin of the Quinsigamond mill, Worcester, Mass., caused by fire on April 5, 1896. This building was erected on the independent plan, a steel frame supporting the floors and

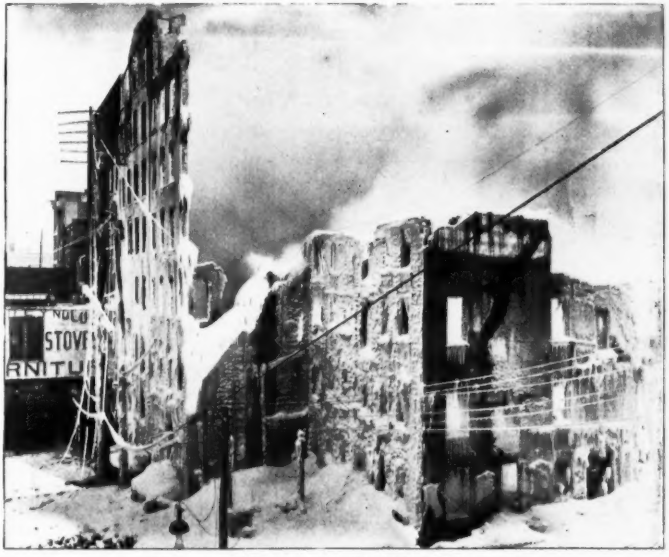


FIG. 1. RESULTS OF A FIRE IN TROY, N. Y.

roof. The columns were of built-up steel, carrying floor-beams of the same material. The window-boxes were of steel, and the walls were of brick built in between the frames so as to enclose the whole. Wood was used for the flooring on the "slow-burning" plan. The photograph very clearly shows the result; how could the destruction have been more complete? The building was entirely gutted, and the columns and beams were twisted into an entangled mass. Witnesses of this fire state that the columns began to yield from fifteen to twenty-five minutes after the fire started, although the floors were not heavily loaded. Had this building been erected on the "slow-burning" principle, it would have resisted the fire much longer. In this type of construction heavy wooden columns and girders are used, which retain for a considerable time, when subjected to fire, sufficient strength to carry their super-imposed loads, permitting the escape of the occupants, the saving of valuables, and the arrival of assistance. Such examples show that plans for all buildings in crowded districts should be intrusted only to the best of designers.

The design would be much simplified if there were no fear of fire. What constitutes a "fire-proof" structure? The term "fire-proof" has become generic, and is in many instances a misnomer. In its usual sense it is used to designate a certain style of modern structure that has become very popular. Structures of this type rely, for their stability, support, and fire-resisting properties, on the steel and iron skeleton frame and on the other non-combustible materials used.

It has been repeatedly proven that metal construction cannot withstand fire, unless well guarded. No matter how "fire-proof" a

FIG. 2. RUINS OF QUINSIGAMOND MILL, WORCESTER, MASS.

FIG. 3. A FIRE-PROOF BUILDING WRECKED BY A FIRE ACROSS THE STREET.

building may be, it will be ruined, if sufficient combustible material is stored within to create a hot fire lasting for a considerable time.

Manufacturers have produced many forms of fire-proofing protection, and have striven to obtain something that will not burn. Architects and engineers have given too much attention to the substance of which the fire-proofing has been made, and not enough to its proper application. It is, however, fortunate that the present

tendency is in the direction of protecting the metal skeleton as a primary object, since upon it the self-sustaining properties of the whole structure depend. It should be a secondary object to so subdivide the floors as to confine the fire.

Without injuring the usefulness or the efficiency of the building, the amount of combustible material now used could, by careful planning, be reduced. In the ordinary American office building wood-work is commonly used to a much larger extent than generally supposed. Taking as an instance a ten-story building of recent fireproof construction, the wood-work in the floors, panels, bases, chair-rails, doors, window frames, and general trim amounted to about two pounds for each cubic foot of contents. This estimate did not include the furniture or movable office-fittings. The total weight of wood was about 1,200,000 pounds, or as much as the weight of the iron frame. In some of the largest and newest buildings the weight of wood-work has been reduced, but there are many in the sky-scraping class in which the wood considerably exceeds the weight of metal.

A number of these tall structures are more vulnerable from fire without than from fire within. The design is often such as to render it difficult for a fire to obtain headway within the building before its discovery, while the same building would be most susceptible to damage if a fire should occur in the immediate vicinity. Designers fail, as a rule, to give due weight to the value of these external hazards. A good example of this is seen in Fig. 3, a photograph of the damage done to the Manhattan Savings Institution Building through a fire on the opposite side of the street. The girders in this building were unprotected, and, failing, permitted the floors to fall.

Some three years ago a joint committee, representing the insurance, architectural, and engineering interests, made some elaborate tests of the effect of fire on full-sized metal columns, finding that such columns failed when heated to a faint red color, representing a temperature of about 1,200 degrees F. The steel columns buckled at the centre, while the cast-iron ones bent, snapping, if not relieved of their load, when the amount of deflection began to exceed the diameter. The time required to cause destruction varied from 29 minutes to 2 hours, according to the character of the test,—a result which agrees very closely with the failure in the Worcester mill. The cast-iron columns were heated to more than 1,100 degrees F., and were then suddenly cooled by means of a fire stream. No injurious effect was produced, beyond the cracking of the furnace brick-work.

The result of our knowledge, based on actual experience and on experiment, is that iron and steel cannot support a load when heated

FIG 4. THE HOME LIFE BUILDING, NEW YORK, AFTER THE FIRE.

to a faint red. The metal must be protected. It will not suffice to have simply a non-combustible protecting material; the material must be of such a character that it can not be disintegrated or dislodged either by water or by expansion. The covering must be so fastened as to remain in place, and such fastening is best accomplished by self-bonding, and not by wiring or similar artificial means. The desire of the owner and real-estate agent to obtain light for halls at the expense of safety, and to economize space by placing the stairs and elevators in the same well, should be strongly restrained.

It has become possible to consider from a practical standpoint this important subject of a fire-proof building versus fire, by taking as an illustration a recent conflagration in New York city. The building in this instance was no doubt much favored in the assistance rendered by one of the most efficient fire departments in the country. On the night of December 4, 1898, a fire occurred in a five-story ordinary brick and wood building, situated on the south-west corner of Broadway and Warren street, occupied by Rogers, Peet & Co., as a retail clothing store. Adjacent to this, on Warren street, was another, but smaller, building of similar design, used as an annex. On the south was the comparatively new Home Life Insurance Building, and, next to it, that of the Postal Telegraph Company.

The general appearance of the Home Life Building is shown in Fig. 4, on the preceding page. It has sixteen stories, and the floor plan is arranged with a light shaft in the middle of the north side. Along this light shaft are the elevators, and next to them is the staircase. The side and rear walls are of brick, while the front is of marble, built solid from the foundations. The building, with the exception of the front wall, is constructed on a skeleton framework of steel. The walls are lined with 2-inch porous terra-cotta furring. The floor arches consist of 12-inch and 9-inch hollow, hard-burned, terra-cotta blocks, the skew-backs covering, with their soffit extensions, the lower flanges of the steel floor beams. The columns are of steel, built up, H sections, and covered with 2-inch porous terra-cotta furring blocks. The girders are protected on their sides with the same terra-cotta blocks, while their soffits are covered with wire lath and plaster. The upper chords of all the girders, except one on the sixteenth floor, are buried in the floors. The principal partitions are made of 4-inch porous terra-cotta blocks without metal supports. Many of these partitions are not continuous to the ceiling, being finished off with large plain glass transoms set in wood framing. All the windows were of glass set in wood sashes and window boxes. There are no shutters. The finish of the office-floors consists of a wooden floor laid on sleepers placed across the floor beams, and not buried in

ashes or cement. The walls and ceilings are plastered. There is a varnished base, chair-rail, window-, door-, and transom-trim.

Within an hour after the fire started, a strong northerly to northeasterly gale was driving the flames from the Rogers-Peet building against the walls of the Home Life Building and into the light well, which acted as a chimney. The fire entered the unprotected windows of the eight upper floors, and found inside a natural draft through the elevator openings. The result was the total destruction of the contents of the upper eight floors, and the saving of the Postal Building by its equally tall neighbor. As a fire stop, the Home Life Building certainly succeeded admirably, for, had it not been there, it is fearful to contemplate what might have resulted during a gale of almost hurricane force. Such buildings are not, however, erected or designed as fire stops, and can be so treated only incidentally.

The vagaries of the flames were as peculiar as ever. In one room where the contents were destroyed a waste-paper basket remained, and in another a towel still hung on a rack unscorched, although the room was totally wrecked. The lower eight stories escaped the fire, but suffered from water.

In the accompanying pictures can be seen the total destruction of the finish of the various floors, nothing being left except the absolute fire-proof material. The plaster work, although not combustible, was absolutely destroyed, and in all of the rooms, from the ninth floor up, there is hardly any plaster left on the walls. The wire lathing used over the pipe chases in the walls and over the various irregularities in the building appears not to have stood the attack of the flames. This may have been due partly to the manner in which it was fastened, but more probably to the fact that the metal expanded sufficiently to throw off the plastering, which has no flexibility. The wood-work used in the finish of the building was not preserved in any of the rooms reached by the fire, except in a few in the rear of the building. In some of these a part of the office furniture still remained, although badly wrecked. In one room on the fifteenth floor a tall wall book-case still stood. The book-shelves were protected by the closely-fitting books placed upon them, while the books were damaged beyond use. Had these shelves, however, been in the front of the building, they, no doubt, would have been destroyed, as there the fire appears to have been fiercest, probably because there were window-openings on the north wall of the east wing. Those partitions which were cut for the purpose of inserting large transom windows near the ceiling suffered most. The glass in these windows no doubt broke, and permitted the flames to spread from room to room, thus removing the value of these partitions as fire stops.

FIG. 5. HOME LIFE BUILDING, 9TH FLOOR—THE LOWEST DAMAGED BY FIRE.
The large safe fell from the floor above.

The accompanying illustrations—Figs. 5 to 10 inclusive—convey a clear idea of the ruin accomplished. The main metallic framework was but slightly damaged. A large proportion of the injury seen in the photographs was done by the firemen and the building inspectors, and cannot be attributed to the flames. In Fig. 5 is seen a large safe, weighing about 4,000 pounds, which fell from the floor above into a room on the ninth floor, lately occupied by the Rapid

Transit Commission. It is reported that the firemen cut a hole in the arch for the passage of a hose, and thus permitted it to fall. Whether this statement be true or not, the ninth floor was sufficiently strong to retain it. The photograph shows the floor beams uninjured.

Fig. 6 shows a view of a room in the front of the building, on the tenth floor. The ceilings and partitions are intact, but the plaster and wood-work were totally destroyed.

FIG. 6. 10TH FLOOR. COLUMN AND GIRDER COVERINGS AND PARTITIONS INTACT. Transom windows seen in partition.

The destruction of the wooden flooring throughout the upper stories was largely due to the considerable air-space between the wood and the flat floor arches. This space should not have existed ; had it been filled, the floors would have stood much longer.

The effect of using other material than wood for flooring is plainly illustrated in the various halls, which were subjected to an enormous heat. The flooring of the halls was made of mosaic blocks. These blocks retained their position, and the floors were practically uninjured, although there is nothing left of the wood flooring in the rooms adjacent. The amount of wood used was no doubt excessive, viewed from the standpoint of best practice. The photographs show that wood-work will not stand a hot fire, even when embedded in the walls. Other material can be adopted for chair-rails, bases, and panellings without injuring the appearance or the utility of a building.

FIG. 7. 12TH FLOOR, FRONT, SHOWING AN EXPANDED METAL PARTITION.

Fig. 7 shows an expanded metal partition in bad condition in a room on the twelfth floor. Some of these expanded partitions were built directly on the flooring, and their failure was caused principally by the burning of the wood, depriving them of their natural support.

Fig. 8 is a view on the thirteenth floor, showing a column with a portion of the fire-proof blocks removed in order to make an examination of its condition. As is clearly seen in the photograph, the column was uninjured and still covered with paint, although the heat in the room was sufficient to destroy the expanded metal and plaster

covering the pipes placed against the rear column. The ceiling in this room and the partition of terra-cotta remain intact, although all the wood-work was totally consumed.

Another column is shown in Fig. 9, which is a photograph of a room in the front of the building on the fourteenth floor. The covering had been removed from this column for the purpose of examination. This picture shows the plaster-work completely destroyed, although the partitions and ceiling blocks remain intact. The floor

FIG. 8. 13TH FLOOR. THE COLUMN AND GIRDER ARE UNINJURED.

arches also remain unbroken, although the safe shown in the picture fell over on its face, on account of the destruction of the wooden flooring upon which it rested. The partition shown in this picture was torn away by the firemen, in order to facilitate their work.

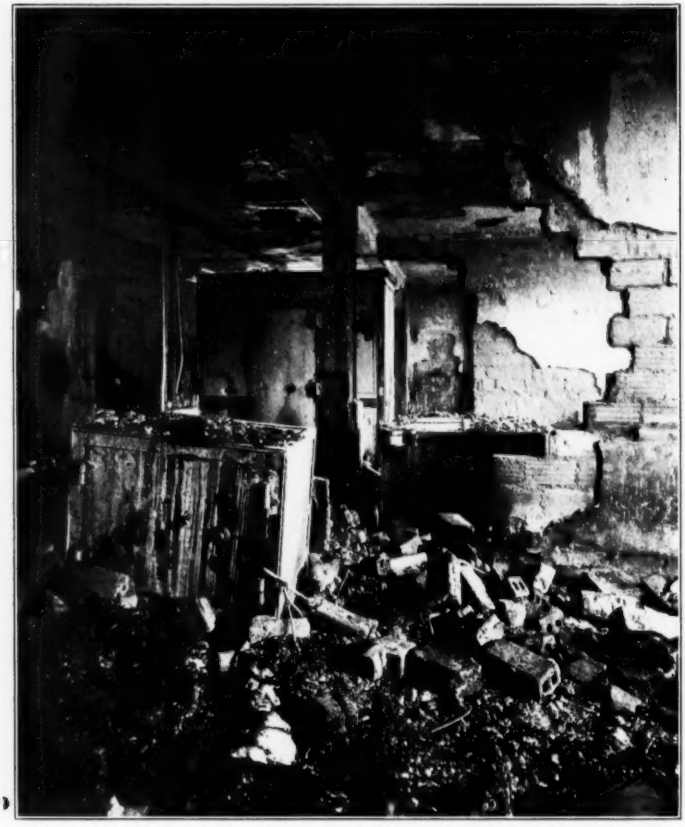


FIG. 9. 14TH FLOOR, FRONT. SHOWS GENERAL DESTRUCTION OF CONTENTS.

Fig. 10 is a photograph taken on the sixteenth floor in a front room of the building. The column remained uninjured, as is shown by the subsequent removal of the terra-cotta blocks. The partitions of terra-cotta on this floor remain intact, although the plastering was completely destroyed. The distorted girder probably represents the greatest damage done to any one member of the metallic frame. This

was one of the main girders of the building, and was protected on the soffit by terra-cotta blocks and wire lath. It differed, however, from the other girders in having its upper chord project above the floor.

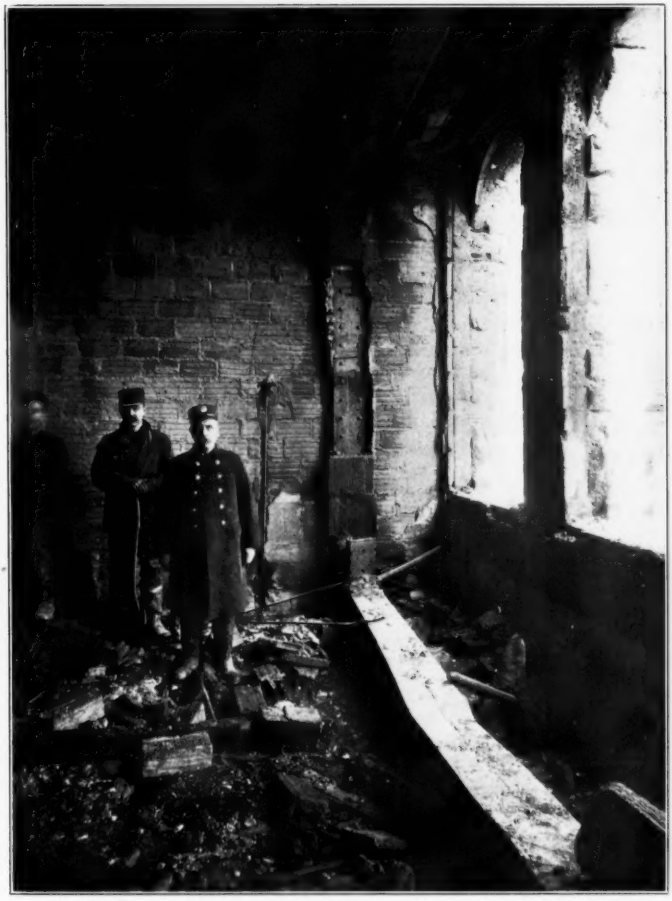


FIG. 10. 16TH FLOOR. A DISTORTED GIRDER IN THE FRONT OF THE BUILDING.

The part projecting was not protected by fire-proofing material, but was boxed in with wood, forming an elevation in the floor-space of these rooms. This wood-work, of course, was completely destroyed, leaving the metal exposed to the fire. No doubt this portion of the

girder became heated, and buckled on account of being in compression. Had the exposed part been in tension, it doubtless would have retained its shape, as there is no evidence to show that the heat was sufficient to have injured it under such conditions.

The fire had no difficulty in entering the building, as all the windows on the north side were unprotected. The building might have been saved, had these windows been equipped with iron shutters, and had wired glass been used in a metallic frame. This wired glass will resist an immense amount of heat, and, although it breaks in time, the pieces remain in place. Metal frames fitted with wired glass could have been used to advantage in all the partition transoms. Such an arrangement would have given nearly as much light throughout the building, and would have been a better fire stop.

The flames, on entering the elevator shaft, appear to have gone at once to the sixteenth floor, as the destruction of the trellis work and iron framing around the elevator doors is greatest at that point. Owing to its position, the staircase was rendered useless as soon as the fire obtained considerable headway, although, as constructed, it was partially protected by the division wall between it and the elevator shaft. The stairs remained intact, so that they could be used as soon as the fire was extinguished.

The front of the building was built of solid marble, the poorer pieces obtained from the quarry being used as backing. The façade was relieved with balconies and other ornamentations, and a row of columns supporting arches made a finish to the fifteenth and sixteenth floors. The fire totally wrecked the marble, wherever it was exposed.

Marble and granite have but little fire resisting power, and it seems useless to adopt them in a building intended to be fire proof. They are so susceptible to heat as to be liable to injury by fires occurring at a considerable distance. A greater heat than that to which the marble was exposed was endured by the brick-work on the north face, and by the brick-work up the light well. The chief visible damage to this was the cracks caused by the expansion and contraction of the braces reaching across the light well and stiffening the two wings.

Taken as a whole, the building resisted the action of fire remarkably well. Within a week many of the offices on the lower floors were again in use. The steel structure, with the exception of a few portions, such as the girder mentioned above, can remain without repairs. The damage to the floors was slight; and, although the total wreck was great, it was practically limited to the trim and contents of the various rooms on the upper nine floors. The front wall, however, was ruined from the eighth story up. No doubt the destruction would have been less, had as much care and energy been bestowed upon the

details of construction and finish as were given to the main frame-work and general plan.

The building contained its own fire apparatus, but it is reported that this failed early in the evening. Owing to the height of the building, it was impossible for the fire department to reach the seat of the conflagration. The fire, therefore, had great liberty, although it was effectually prevented from spreading to the lower floors.

Here was a building which was, in the ordinary sense, a fire-proof structure, and yet it was damaged. Again arises the question: "What constitutes a fire-proof building?" It is evident that, if fire is brought into contact with articles that are combustible, those articles will be burned; and that, if the fire must be confined to one specific space, that space must be enclosed effectually by absolutely fire-resisting material, which must be so constructed as to form practically a furnace. Such construction is not applicable to a building used for ordinary purposes. The next step, then, is to so arrange the structure that, when fire takes place, no damage shall be done to the main members, whether those members be of masonry, iron, or steel.

In all our cage constructions the members needing the greatest protection are the columns, girders, and beams. It is not difficult to protect these members effectually, provided the owner and the designer are willing not only to spend the proper amount of money and care, but to give up the requisite floor-space. This part of the problem was fully illustrated in the Home Life Building, as the only members seriously injured were the unprotected parts of the metal structure. It is axiomatic to state that floors should be separated from each other, so as to confine the flames. This is a condition difficult to attain, as perforations must be made for both stairs and elevators. These openings are generally placed so as to take a minimum of floor-space, and thus render a maximum area available for income-earning purposes. Nearly every intending builder examines the various buildings, estimates the amount of space devoted to public use, and concludes that the best building is the one that has given up the least percentage of space. While this effort is commendable from the purely income earning standpoint, it not only has the effect of rendering the design dangerous to life and property, but makes it almost an impossibility to so design a building that it shall be fire-proof.

In any building there must be, and always will be, an amount of combustible matter that cannot well be reduced. It is, therefore, essential that the least amount of combustible material shall be used in construction. In those rooms in the Home Life Building which suffered the least damage, it was clearly shown that the combustible materials placed near the ceiling were destroyed more rapidly and more

FIG. 10. SUGGESTIVE OF THE DIFFICULTY OF REACHING THE UPPER STORIES OF A SKY SCRAPER WITH A FIRE STREAM.

completely than those nearer the floor. The heat and flames naturally follow the ceiling, and the ordinary fire-proof partitions in which there are large transom windows are thus rendered useless as fire stops. The use of transoms in these partitions is no doubt a necessity, but they should not be fitted with material so friable as ordinary glass.

Even in a fire-proof building dependence must be had upon human aid. When the building is tall, it towers beyond the reach of the fire department, and reliance must be placed upon other means.

A fire in the lower stories is easily accessible; the conditions to be most dreaded are those of a fire in the upper stories. The difficulty can be inferred from Fig. 10, which is a view of Broadway, N. Y., from one of the upper floors of the American Surety building. Many modern tall buildings are designed with their own pumping plant to supply a roof tank for fire and other purposes, and are equipped with a large stand pipe from six to eight inches in diameter, which is siamesed on every floor for hose connections. This stand pipe is also arranged with a check valve and with siamesed branches at the foot, so that fire engines can be attached, in case of the disability of the self contained plant. It is well so to arrange the stand pipe that the engines can also operate in conjunction with pumps in the building.

In many cities which maintain a system of fire boats there are laid underground pipe lines of large diameter. As these fire boats are equipped with pumping apparatus far exceeding the power of the largest land engines, they are able to force water under heavy pressures to long distances, provided the mains are made of sufficient area to minimize the friction losses. This system, operated in connection with the building stand pipe, would materially assist the firemen.

The question naturally arises whether it pays the owner to make a building thoroughly fire-proof. Unfortunately there are many who build for the specific object of obtaining the greatest income from a minimum outlay, and the effort to save on the first cost is so great as to render their judgment valueless as to what should or should not be done. Tall buildings of cheap construction are a menace not only to the owner and tenants, but to the community. Too much stress cannot be laid upon the great aid that could be rendered, but unfortunately is not, by the insurance companies. If they would be more strict in the classification of their risks, improvement would immediately follow.

Are these tall buildings really good investments? The increase in height appreciates the value of the land, but how much of this appreciation is offset by the depreciation of the building, by the extra cost of maintenance, insurance, repairs, taxes, interest, etc.? In other words, would not a smaller building pay a greater percentage upon the money invested, if a careful and accurate balance sheet should be drawn up? Following the same line of thought, there has arisen the question whether the height of buildings should not be limited by law? If every building could be constructed upon utopian principles, probably there would be no reason to limit the height other than one of a purely æsthetic character. As such a state of affairs does not, and probably never will, exist, and as so-called fire-proof buildings are liable to be constructed, it seems that some form of proper restriction would be advantageous to the community.

FAST RUNS ON THE NORTHERN RAILWAY OF FRANCE.

By Charles Rous-Marten.

DURING four recent visits to France it has been my privilege to make many observations of the locomotive work on the Northern Railway of France. I may at once say frankly that the results obtained completely eclipse any that have come under my notice in the course of my many years' experience of British railways.

If I do not make comparisons with American work, it is because my American experiences have yet to come, and I do not, as a rule, deal with any performances that I have not myself personally recorded. My only exceptions consist of cases which are authenticated beyond reasonable doubt. Pending, therefore, the personal observations of railway work in the United States which I hope to be able to make at no distant period, I limit my comparisons to France and Great Britain exclusively.

Few things are more surprising in railway history than the progress which has been made by the Chemin de Fer du Nord to the high place—virtually the first place—which it now holds among European railways. Of all the continental lines it now is *facile princeps*. There is no other railway on the continent which approaches it in smartness. Even in England it has no rival in start-to stop speed. The Great Northern approaches it most closely, with two runs timed at 55.3 miles an hour, while the Great Central has a short distance booked at 55. But against these the Chemin de Fer du Nord has one booked at 57.7 and one at 56.3, besides two at 55.3, the English Great Northern maximum. In Great Britain there is only one line which compares with this French railway. The Caledonian Railway of Scotland has led all British lines in respect of speed since July, 1895, and still holds first place for the fastest booked run, —*viz.*, a short one of 32½ miles at 59.1 miles an hour, besides another at 56.5 and a third at 55.6., all unequalled on any other road in the United Kingdom.

When it is remembered that ten years ago the Northern Railway of France had no run booked faster than 43 miles an hour from start to stop, and that, without having the stimulus of competition, it has improved its services until now it has no fewer than 26 express journeys timed at a speed of 50 miles an hour and upward from start to stop, it will be realized how great has been the progress in a single decade. How admirable is the present service may be perceived by a glance at the following table of runs timed at 50 miles an hour or more:

STATIONS.	Distances in miles.	Times allowed. Hrs. min.	Average speeds in miles. per hour.
Paris—Amiens	81¾	1.25	57.7
Paris—St. Quentin	95¾	1.42	56.3
Boulogne T.—Amiens	77½	1.24	55.3
Amiens—Boulogne V	76¾	1.24	54.8
Paris—Amiens	81¾	1.30	54.5
Compiègne—Paris	52¾	1. 0	52.7
Paris—Longueau	79	1.30	52.6
Longueau—Paris	79	1.30	52.6
Creil—Amiens	50	0.57	52.6
Calais Pier—Amiens	104	2. 0	52.0
Amiens—Calais Pier	104	2. 0	52.0
St. Quentin—Jeumont	52	1. 0	52.0
St. Quentin—Paris	95¾	1.51	51.8
Paris—Amiens	81¾	1.35	51.6
Longueau—Arras	41¼	0.48	51.6
Longueau—Creil	47¼	0.55	51.4
Abbeville—Boulogne T	49½	0.58	51.2
Boulogne T.—Abbeville	49½	0.58	51.2
Amiens—Paris	81¾	1.36	51.1
Amiens—Abbeville	28	0.33	50.9
Amiens—Calais Ville	102½	2. 2	50.4
Paris—Creil	31¾	0.38	50.1
Creil—Paris	31¾	0.38	50.1
Amiens—Creil	50	1. 0	50.0
Tergnier—Amiens	50	1. 0	50.0

Such a list as this would be a credit to any railway—even an American one! How it contrasts with the English lines with which it connects by means of the cross-channel services may also be perceived by comparing the French Northern schedule above with the following, which is the best the South Eastern and London, Chatham & Dover lines can show in connection with the French services;

STATIONS.	Distance in miles.	Times allowed. Hrs. min.	Average speeds in miles. per hour.
Herne Hill—Dover (L. C. & D)	74½	1.35	47.1
Cannon Street—Dover (S. E.)	75½	1.44	45.3
Charing Cross—Folkestone (Direct) (S. E.)	70¾	1.34	45.1

It must be confessed that the contrast is not soothing to British insular pride. And this contrast is experienced by all travellers between London and Paris *via* Calais or Boulogne. Supposing a passenger to leave Paris by the 9 A. M. train for London, he experiences five runs, successively timed at 50.1, 52.6, 51.0, 51.2, and 47.• miles an hour, the last being along the short distance between Boulogne and Calais and over steep grades. Or he may leave at 11.50 A. M. and

have two runs respectively at 51.6 and 50.4 miles an hour, to Calais. These trains cover the distance from Paris to Calais, one mile farther than from Manchester to Euston (London) and over a harder road, in, respectively, 29 and 33 minutes less than the fastest London & North Western time for that journey. Or he may go by the *train de luxe* at 12.20 and make his first run at 57.7 miles an hour, reaching Calais pier in 3½ hours, including a 5-minute stop at Amiens, this being 45 minutes quicker than the fastest time from Manchester to London, while the distance is two miles longer.

If it be said that there is some unfairness in comparing the best French service with some of the poorest in England, I may point out that my object is simply to show the astonishing advance made by the French railway, seeing that ten years ago even such a comparison would have been all the other way. But beyond this it may be observed that, whereas there is no train timed to do its first stage out of London at so fast an average rate as 54 miles an hour, the French Northern has no fewer than three booked to make the first run out of Paris at more than 54 miles an hour,—*viz.*, one at 54.5, one at 56.3, and one at 57.7. Moreover, the Chemin de Fer du Nord has two runs timed faster than any on the English Great Northern, three faster than any on the Midland, London & North Western, Great Eastern, North Eastern, Great Central, or London & South Western; 15 faster than the best on the Yorkshire & Lancashire; 22 quicker than any on the North British; and more than 30 faster than any on the South Eastern, London, Chatham & Dover, or London, Brighton & South Coast—with the single exception, in the case last-named, of the one train, restricted to a limited number of first-class passengers, which has just been put on from London to Brighton and back (50¾ miles) on Sunday only, to do the distance in 1 hour. And this takes no note of many excellent trains timed at 47 to 49 miles an hour.

The main line of the Chemin de Fer du Nord, after leaving the fine terminus situated in the Rue de Dunkerque, in the north-east quarter of Paris, goes nearly due north to Creil, 31¾ miles, where it bifurcates into two main lines. One takes a generally north-northwest course, to Amiens, Abbeville, Boulogne, and Calais—185½ miles from Paris; the other runs northeast to Compiègne, Tergnier, and St. Quentin, reaching Jeumont, on the Belgian frontier, and connecting there with a continuous chain of railways leading to Cologne, Berlin, and St. Petersburg. The distance from Paris to Jeumont is 147¾ miles. As these are the lengths on which all the best work is performed, I confined my attention to them almost exclusively. The Nord has other main lines to Soisson and Laon on the eastern side, and to Beauvais and Le Treport on the western, but the

average speeds on those sections do not exceed 47 miles an hour, and are, as a rule, much lower.

It will be sufficient, therefore, if attention be confined to the two principal main lines of the four possessed by the Nord,—those to Calais on the one hand and to St. Quentin on the other.

The two have a common road as far as Creil, and diverge just beyond, 32 miles from Paris. For the first 4 miles after leaving the metropolis the line falls on an easy grade. Then, from St. Denis, there is an ascent for 12½ miles at 1 in 200, succeeded by a drop at 1 in 200 for about 15 miles. This brings us to Creil, where the line bifurcates. Continuing toward Calais, there is next a rise, practically continuous, for 23 miles, chiefly at 1 in 250 and 1 in 330, with shorter lengths at 1 in 400. Then comes a fall for 27 miles, also virtually unbroken, nearly all at 1 in 250 and 1 in 330. By this time Amiens is reached. In this distance of 81¾ miles two huge gables have to be climbed over, their sides being respectively 12½, 13, 23, and 27 miles, so that the road is by no means an easy one.

After Amiens an almost dead level extends for about 60 miles. Then the line rises 4 miles at 1 in 135, and drops for the same distance at the same rate. A short level and shorter climb brings us to Boulogne-Tintelleries station on the main line, a short branch leading to the other town station and to the pier. Leaving Boulogne-Tintelleries, the heaviest bit of the whole line has to be passed over, including an eight-mile rise at 1 in 125, somewhat broken, but 6 miles being continuous, and a continuous fall, also at 1 in 125, for eight miles, which brings us to the level area on which Calais stands.

On the other hand, if we turn off at Creil toward St. Quentin, we find first a 50-mile stretch of nearly dead level, having, however, a slight rising tendency. This is followed by a continuous rise at 1 in 333 for ten miles, and then a drop at the same rate for 5 miles, completing the journey to St. Quentin. This, though easier than the Calais line, is assuredly not the "unbroken level" which it is commonly represented as being.

Now, what are the engines which haul the trains at the high speeds shown in the tables. Up to five or six years ago all the express work on the Nord, which was then of a relatively mild type in respect of speed, was performed by engines of a class known as "Type Outrance," illustrated on page 795. This title probably was first given to them in compliment to their extreme speed,—they were the fastest engines on the continent,—and the name is retained.

It will be noticed from the illustration that the engine has what is very rare on the continent,—outside bearings for the coupled wheels, and external cranks for the coupling rods. Translating the French

dimensions into the nearest English equivalents, I may say that the coupled wheels are 6 feet 10 inches in diameter, the cylinders are 17 inches by 24 inches, and the boiler has 1,082 square feet of heating surface and carries a steam pressure of 156 pounds to the square inch. The original pressure, however, was only 142 pounds. The total weight of the engine loaded is 43 tons, and the weight available for adhesion is 28 tons. Thus, allowing for differences in details and fittings, it will be seen that this engine was very much after the English type of a few years back, and even has many points in common with the latest design of the Great Western Railway.

At present they are not employed, as a rule, on the best express duty, but they occasionally take a turn on important trains, and I had several trips with them. Having regard to the limitations of their capacity, they did very good work. As much as six years ago the Nord mid-day express was run from Paris to Calais-Ville in 4 hours 9½ minutes, or 10½ minutes less than the present quickest time from Manchester to Euston, the latter being by a mile the shorter distance.

But they have long been utterly overweighted by the modern train loads, which have to be hauled at a speed never dreamed of in France in the days when they were built, and so the very able *ingénieur en chef de la traction*, M. du Bousquet, came to the conclusion that a new and important departure was necessary.

In view of the straitened limits imposed by the standard gauge of 4 feet 8½ inches on the development of boiler dimensions, M. du Bousquet became convinced that increased power must be sought in the more economical employment of the steam, and that some form of compound engine would best fulfil this desideratum. Accordingly he decided to adopt the type of four-cylinder compound which had been designed by M. de Glehn, *administrateur-directeur* of the celebrated Société Alsacienne des Constructions Mécaniques, which has extensive works at Belfort and Mulhausen, situated respectively on the French and German sides of the Alsace frontier. M. du Bousquet having specified the class of engine and the power desired and the details needed to suit the engine to the requirements of the Nord line, M. de Glehn proceeded to build, and up to the present time has constructed fifty of the four-coupled class, which now perform all the principal fast express work.

The first two that were built, which constitute Sub-Class I., were considerably smaller than their successors, although having the same diameter of cylinders and driving-wheels and the same length of boiler and piston-stroke. From the outset the diameter of the coupled wheels was fixed at 6 feet 11¼ inches, that of the two high-pressure cylinders at 13.4 inches, that of the two low-pressure cylinders at 20.9

inches, the length of the piston-stroke at 25.2 inches, and that of the boiler at 12 feet 10 inches between the tube plates. Stated roughly, it may be said that the high-pressure cylinders are 13½ by 25, the low-pressure 21 by 25, and the coupled wheels 7 feet. The two pioneer engines, which were numbered 2.121 and 2.122—the first numeral, followed by a point, representing the *class* reckoned by the number of axles coupled—had a heating-surface of only 1,200 square feet in the tubes, those of the ordinary kind being used; the firebox added 117 feet, making 1,317 square feet in all. The fire-grate area was 22 square feet. The steam pressure was 198.7 pounds.

After two years' favourable experience with these engines, fifteen more (Nos. 2.123 to 2.137) were built, with largely-augmented boiler-power, the heating surface being increased to 1,553 square feet in the tubes and 117 feet in the firebox, or 1,670 square feet in all. With these engines the Serve tubes were used. Success still attending the compound engines, 20 more (Nos. 2.138 to 2.157) were constructed in 1895, forming Sub-Class III. These retained all the main dimensions of the earlier class, but adopted the enormous steam pressure of 213 pounds, working ordinarily up to 214 and 215 pounds. Finally Sub-Class IV. came out, in which the boiler power was much enlarged, the heating-surface being increased to 1,768 square feet in the Serve tubes and 122 square feet in the firebox, making 1,890 square feet in all, the fire-grate area being simultaneously enlarged to 24 square feet. These dimensions manifestly afforded vast capacity of steam-generation. One consequence of the progressive development was to raise the weights (loaded) from 47 tons, 16 cwt. in Sub-Class I., to 48 tons, 11 cwt. in Sub-Class II., 48 tons, 19 cwt. in Sub-Class III., and 50 tons, 9 cwt. in Sub-Class IV.,—the latest type. Another result was that a larger tender was employed, placed on two four-wheeled bogies and weighing 40 tons loaded. It carries 4,000 gallons of water and a proportionate supply of fuel.

In all the engines the two high-pressure cylinders are placed outside the frames, behind the leading bogie. They drive the rear pair of coupled wheels. The two low-pressure cylinders are inside, under the smokebox, and drive the double-throw crank-axle on which the front drivers are fixed. The two pairs of wheels being coupled, instead of running free with independent action as in the case of certain British engines, no trouble ever arises through a want of synchronism in the two sets of machinery, which constitute virtually two separate engines with one boiler and frame. I illustrate Sub-Classes II. and IV. of the four-wheeled coupled class of compounds on pages 796 and 797.

My observations as to the work of these engines may be divided into four classes: (1) special experiments with light loads at highest

speeds, tested by elaborate methods in a dynamometer van; (2) similar experiments with ordinary fast expresses and moderate loads; (3) "surprise" journeys made without any previous intimation and without knowledge on the part of the officials that the work was being tested; (4) exceptionally heavy loads hauled at high speeds. The last two may be conveniently associated as one division of my subject.

In all cases excepting those of the "surprise" visits, most elaborate arrangements were made for testing the character of the work done. A four-wheeled dynamometer van was employed. It was placed just behind the tender, and had abundant side and front outlook, while it was fitted with all the apparatus needed for its functions. An automatic speed-recorder was actuated by a belt from one of the free-running axles of the van. An apparatus connected with the tender drawbar recorded the tractive force exercised. A broad band of paper moved by clockwork under two election pencils, one black and the other red, each operated by a button at the end of a cord, the two pencils being used by different inspectors, who noted with chronographs the passing of each station, signal-box, and kilometre-post. For myself, I used the arrangement of split-seconds chronographs described by me in the February (1898) number of this magazine, being thus able to note the time of passing every kilometre-post and point of interest. One inspector, who knew the road well, was specially detailed to watch for the posts, etc., and he gave five seconds' warning as each was approached. I can hardly imagine a more thorough and complete system of observation. I must express my thanks to two of the gentlemen who accompanied me on this interesting and memorable series of expeditions, and who took the principal part in making and carrying out the necessary arrangements, of course under the authority and instructions of M. du Bousquet, whose courtesy and kindness I cannot too warmly acknowledge. M. Jacoupy is one of the principal inspectors of the locomotive department of the Chemin de Fer du Nord, and I found him a most able and well-informed officer, as also was M. Rudloff, who is in charge of the locomotive depot, where are stabled the engines employed in the "Service Centrale" of the Nord. He always travelled on the footplate, and directed the respective drivers as to the special duty required of their engines at particular points of the road. M. Jacoupy took charge of the dynamometer van and, I may add, of myself. I cannot speak too highly of French hospitality and kindness as exemplified by him. Other gentlemen who assisted in the experiments were Messieurs Poupée, Pellieux, Poisson, and Channeur, to all of whom I desire to express my cordial acknowledgements. The results have no authentic parallels in Europe.

First in order among the trials was one with a train representing the "Rome Rapide," which is booked at 57.7 miles an hour from Paris to Amiens. An engine of Sub-Class IV. was used, and the load was 148½ tons behind the tender. In all cases the weights given are exclusive of engine and tender, the only accurate and scientific mode of computation. It may be well also to mention here that the maximum speed on all French railways is strictly limited by law. The Nord is allowed the highest point,—*viz.*, 120 kilometres per hour (74.4 miles) for ordinary expresses, and 125 kilometres (77.5 miles) in specially authorised cases. These limits are most rigidly adhered to; so my readers must not anticipate any exceptional maxima in these official trips. Some were attained in separate special experiments, but those I shall deal with apart from the others.

Starting the long ascent at 1 in 200 at 58 miles an hour, we kept at this speed for the first 4 miles. Then the speed rose to 59, and stayed at that for a couple of miles, 60 to 61 miles an hour being steadily maintained thence to the summit. The 12½ miles occupied exactly 12½ minutes. The descent toward Creil calls for no remark, but Creil station was passed, slowly, in 30 minutes, 32 seconds from Paris, the distance being 31¾ miles. In spite of our slowing through Creil, we rapidly attained 65.2 miles an hour up the 5 miles of 1 in 400 which is encountered immediately after Creil, and on a short level length intervening the rate quickly rose to 70. This was diminished to 62 by the following ascent at 1 in 250, but never fell lower to the top of that rise; and, when the grade eased to 1 in 330, the speed rose to 64 miles an hour, and was still increasing at the summit. In the subsequent descent toward Amiens the "special" legal limit of speed, 125 kilometres (77.5 miles an hour), was reached, but here, as in the previous descent, progress was interrupted by a bad slowing for heavy road-repairs, and a later check proved to be our too-early approach to our destination. This compelled us to "ease down," and we ran the last 5 miles with steam shut off. The distance of 81¾ miles from Paris, over the two "gables," occupied 79 minutes 56 seconds from start to stop, but, allowing for the carefully-ascertained loss of time, through road-repairs, — ordinary "service slacks" being ignored,—the net time was 76 minutes 24 seconds. On a subsequent occasion, with the train running in its ordinary course, the time was 79 minutes 13 seconds.

Next we experimented with the so-called "Nord Express," bound for Cologne, Berlin, and St. Petersburg, which is timed at 56.3 miles an hour from Paris to St. Quentin,—95¾ miles. The normal load of the "train de luxe" is about 100 tons, but on this occasion it was increased, by our dynamometer van and two extra 33-ton corridor

coaches, to 178 tons. This militated against a speed-record, but showed to greater advantage the vast haulage-power of the locomotive, which was the same one used in the preceding case. In spite of the load being 30 tons heavier, the ascent of the 12½ miles of 1 in 200 was again made at an average rate of 60 miles an hour. Diverging at Creil, after the usual slack, our speed rapidly increased to 68.5 miles an hour on the long stretch of level and slightly-rising road, but, unfortunately, adverse signals brought us to a dead stand at Compiègne, 52¾ miles from Paris, this having been done in 51 minutes net. Resuming, we attained 69 miles an hour on the level, and sustained 65 up the bank of 1 in 333. The train being much before time, the downhill length to St. Quentin was done without steam, the running time from Paris being 95 minutes 9 seconds for the 95¾ miles, or 90 minutes 48 seconds net. It should be noted that during this run the speed at no point exceeded 70 miles an hour. All the gain of time was in the uphill work. On a second occasion the trip was done in 94 minutes with the normal load.

But the final run of this series proved in some respects phenomenal, as the fastest from start to stop ever made in Europe. The engine was one of the same class; the load was the normal one *plus* the dynamometer van, or 114 tons 7 cwt. in all behind the tender. In this instance the uphill running greatly surpassed anything in my previous experience. So quickly did the engine gather speed that we were running at 60 miles an hour in two miles from the start, 70 in three miles, and 71.3 in four. Here we began to climb the 12½-mile bank at 1 in 200, and up the whole of that length the speed averaged 67 miles an hour,—the highest average achieved during the Aberdeen race, including downhill and level. In this case the whole distance was uphill. The speed ranged between 65 and 69 miles an hour, the former being through stations; it was 68 and still rising when the summit was attained. The subsequent descent to Creil was made at the maximum speed permitted,—*viz.*, 77.5 miles an hour,—and Creil (31¾) miles was passed in 28½ minutes from the Paris platform. Along the 50 miles of level and slight rise which succeeded, a rate of 75 miles an hour was persistently maintained, interrupted only by faint slackenings past stations or junctions; in one case this speed was run without variation for 10 miles on end, all the distance being level or slightly uphill. Then came the 10 miles ascent at 1 in 333; starting this bank at 40 miles an hour, after a slack through Tergnier, the speed steadily rose all the way up, until, just before the summit, the rate was 70 miles an hour; it was still increasing when the summit was passed. These uphill performances are without parallel in my experience. The run from Paris to St. Quentin was done in 85

minutes 11 seconds net, or at an average speed of 67.4 miles an hour.

The gross time, including what were practically three stops for crossing backward and forward at the points where single-track working was necessitated by heavy road-alteration,—cases in which French practice exists on exceptional precautions,—was 91 minutes 52 seconds, start to stop. The net time, 85 minutes 11 seconds makes no allowance or reduction for the regular service slacks at Senlis Junction, Creil, Compiègne, or Tergnier. These, however, if taken into due account, represented a further loss of fully 5 minutes. If those two were subtracted, the result would show that the actual locomotive-work was an average speed of 71 miles an hour up and down grade, and without allowing for the gradual attainment of speed after starting, or for the gradual slowing before the stop. This would undoubtedly have been exceeded in a similar American run, because the downhill speed would have risen to 88 or 90 miles an hour; but this is not permitted in French practice with regular trains. That the engines can attain the highest speeds yet authentically known is, however, certain; for once, when making a special trial, I obtained a speed of 85 miles an hour on a falling gradient, and the engine then was not exerting its full power. The rate was rapidly mounting when the foot of the slope was reached, and an uphill length succeeded, so that on that occasion no increased velocity could be got.

Proceeding next to my experiments with the ordinary fast expresses having moderate loads and running in their customary course, I may select, for my first illustration, the "Calais-Basle" express, which ran nightly during the summer, and was timed to make the journey from Calais pier to Amiens, 104 miles, in 1 hour 58 minutes, including a 2 minutes' stop at Boulogne-Tintelleries, the run of 77½ miles thence to Amiens being booked to be done in 84 minutes, or at the average rate of 55.3 miles an hour.

A late arrival of the boat from Dover made our departure more than half an hour late; so considerable scope was afforded for "making up." Unluckily heavy permanent-way works were in progress about half-way up the long bank of 1 in 125 to Caffiers, compelling single-line working and consequent delay. Thus on the first stage to Boulogne, nothing particular could be done, and our energies had to be reserved for the next stage—to Amiens. I have already described the road. The engine was one of the 2.158 type —Sub-Class IV. Fig. 3—the latest and most powerful type. The load consisted of eight vehicles, including a dining-car weighing 32 tons; the total weight behind the tender amounted to 134 tons.

Notwithstanding the obstacle already mentioned, which involved a delay of 3 minutes, the distance of 26¾ miles from Calais pier to

Boulogne-Tintelleries was done in 28 minutes 51 seconds, although there was an up grade at 1 in 125 for nearly 11 miles of the way. But from Boulogne onward a clear run was secured to a point a mile short of Amiens, where more road-repairs brought us almost to a standstill. The length of 76½ miles from Boulogne to that point was run in 70 minutes 53 seconds, but, owing to the check, the final mile into Amiens station took 3½ minutes, making the total time from Boulogne (77½ miles) 74 minutes 23 seconds, from which 1 minute 53 seconds should be deducted for the delay. However, this run to St. Roch, where the delay occurred,—*viz.*, 76½ miles in 70 minutes 53 seconds,—would have been an excellent one in any circumstancess What rendered it specially remarkable was that it was accomplished without once exceeding a maximum rate of 70 miles an hour. That maximum was only once just touched, all the rest of the way the speed varying between 63 and 68 miles an hour. Thus even the prescribed ordinary limit was not reached, the maximum attained being 112 kilometres as against 120 authorised. This shows a surprising evenness and steadiness of running. It should be noted that the train made up 9 minutes 37 seconds, or, if the check be taken into account, 11½ minutes, on a timing at 55.3 miles an hour.

The corresponding train, being only a few minutes late in starting, was unable to do all that might otherwise have been done. As it was, Boulogne was reached from Amiens in 77 minutes 29 seconds, a minute before time, the load being the same as in the other case cited, but the engine was one of Sub-Class III., instead of Sub Class IV.

In the case of the 10.30 A. M. express from Paris to Boulogne, the running time allowed is exactly 3 hours for the 158¼ miles. A stop of 20 minutes is made at Amiens for *déjeûner*. This, of course, I have excluded from the time-calculation. On the occasion when I tried it the engine was one of Sub-Class IV., and the load 145 tons behind the tender. The run of 81¾ miles was accomplished with the utmost ease in 82 minutes 58 seconds, showing an average rate of 59.1 miles an hour. The maximum speed was kept well under the legal limit, and the ground was got over by fast uphill work, 62 miles an hour being steadily maintained up the 12-mile bank of 1 in 200. The journey was made in 7 minutes 2 seconds under time. The continuation to Boulogne was done in 6¾ minutes within time, the 76¾ miles to Boulogne Ville occupying 83¼ minutes under easy steam.

Dealing next with my "surprise" journeys, made without previous intimation to the authorities or knowledge on the part of the officials, I may select two particular experiences. In each case the train was the day mail from Calais connecting with that leaving London at 9. A. M. This train has to run the 184¼ miles from Calais-

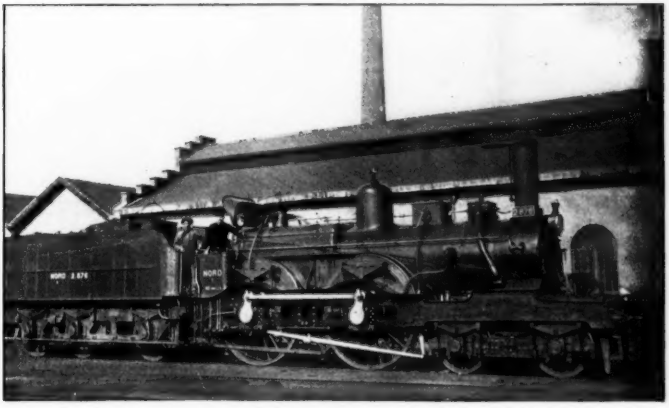


FIG. I. NON-COMPOUND EXPRESS ENGINE, CHEMIN DE FER DU NORD, FRANCE.
"Type Outrance," predecessor of the four-cylinder compound.

Ville to Paris, over the road already described, in 3 hours 54 minutes with four stops aggregating 9 minutes. In each case the engine was of Sub-Class IV. In the earlier journey the load throughout was twenty coaches, weighing, in all, 265 tons, exclusive of engine and tender. Owing to baggage and customs detentions at Calais, the departure was 18 minutes late, and the train had to stay 10 minutes over time at the stations, beside being stopped thrice by signal. Nevertheless, the engine actually gained 23½ minutes in the running-time with that load, and in spite of those drawbacks. A speed of 41 miles an hour was maintained up the 8-mile Caffiers bank at 1 in 125; 62 on the level between Boulogne and Abbeville; 53 to 55 up the banks at 1 in 250 and 1 in 300 after Amiens; while the 15-mile ascent of 1 in 200 after the start from Creil to the Survilliers Summit was mounted in 20 minutes 6 seconds.

In the second case the load was eighteen coaches (268 tons) from Calais to Amiens and twenty (290 tons) thence to Paris. Starting from Calais-Ville 16 minutes late and staying 10½ minutes over time at the stations,—four in all,—the train, although then 26½ minutes late, actually reached Paris a minute before time, having thus gained 27½ minutes on the schedule! This remarkable feat was achieved though the smart work up the banks. Up the 8 miles of the bank at 1 in 125 to Caffiers 42 to 43 miles an hour was sustained; up the 25 miles of 1 in 250 to 1 in 333 after Amiens, 53 miles an hour; and, up the 13 miles of 1 in 200 after Creil, 50 miles an hour was the minimum. I could quote other performances of similar merit.

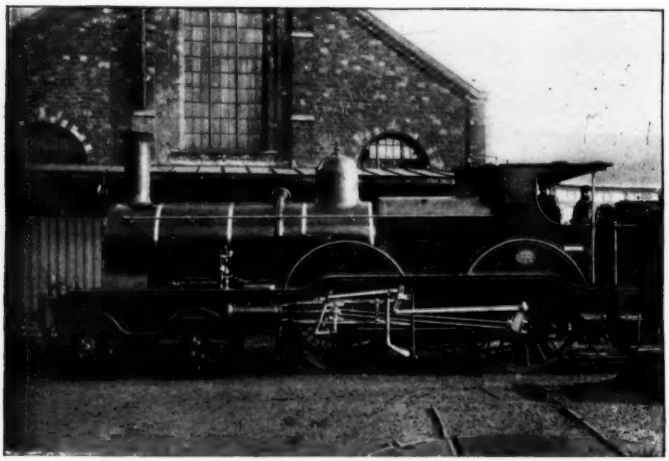


FIG 2. FOUR-CYLINDER COMPOUND EXPRESS ENGINE. SUB-CLASS II.

Among my experiences with heavy trains fast-timed, a run with the Lille corridor express holds a high place. The engine was one of Sub-Class IV., and the load aggregated 270 tons 6 cwt. Timed to run the last 79 miles from Longueau Junction (2¾ miles on the Paris side of Amiens) to the Gare du Nord, Paris, in 90 minutes, or at 52.6 miles an hour, the engine succeeded in gaining 3 minutes 52 seconds. The start had to be made at the foot of a 23-mile ascent of 1 in 333 to 1 in 250. Up this grade 52 miles an hour was persistently sustained, there being only one drop to 51.6 in passing over station points, while the speed actually increased to 55 up the steeper gradient of 1 in 250 toward the summit. Up the long stretch of 1 in 200 after Creil, 50 miles an hour was maintained, and for official reasons no faster rate than 70 was run down the descent approaching Paris.

A journey with one of the earlier type of 4-cylinder 4-coupled compounds (Nos. 2.123—2.137), Sub-Class II., was noteworthy. The engine hardly differs from the later type, the only points of variance being that its steam pressure is 199 pounds instead of 213. Taking the Cologne-Paris fast express from St. Quentin to Paris, exactly 2 hours being allowed for the 95¾ miles, the engine drawing a load of twenty coaches, or 274 tons, the run to a signal stop just outside the Paris station was made in 1 hour 53 minutes 25 seconds, although there was a loss of fully 5 minutes through the heavy permanent-way alterations mentioned in connection with the fast trip in the opposite direction. Work of this sort calls for no comment.

Following in some degree a point of recent American practice, the Chemin de Fer du Nord has introduced a new type of engine, originating, like the others, at the ateliers of the Société Alsacienne, and designed by M. de Glehn, in consultation with M. du Bousquet as to details specially suitable to the French Northern line. These engines, which are numbered 3.121 to 3.170, run on ten wheels, six being coupled, and have four-wheeled bogies. They have 1,950 square feet of heating-surface, 24.4 square feet of grate area, and 213 pounds of steam pressure. Four-cylinder compounds like the other types referred to, these have two 13.8-inch high-pressure cylinders, outside, and two 21.6-inch low-pressure cylinders inside. The piston stroke is 25.2 inches. The six coupled wheels are 5 feet 8¾ inches in diameter. Loaded, these engines weigh 58 tons 12 cwt., without tender.

Although designed chiefly to run heavy stopping trains and fast goods trains, these engines occasionally take their turn at express work; indeed, they regularly run certain expresses which are heavily loaded and have steep grades to contend with. They sometimes even take the fast mails between Paris and Calais. I had several trips with them in this work, and found that they invariably perform it with the utmost ease. That the heaviest train loads permitted by law in such services would be child's play to so powerful engines, even up the steepest banks on that line, is obvious; but a specially noteworthy feature of their performances was the ease and readiness with which

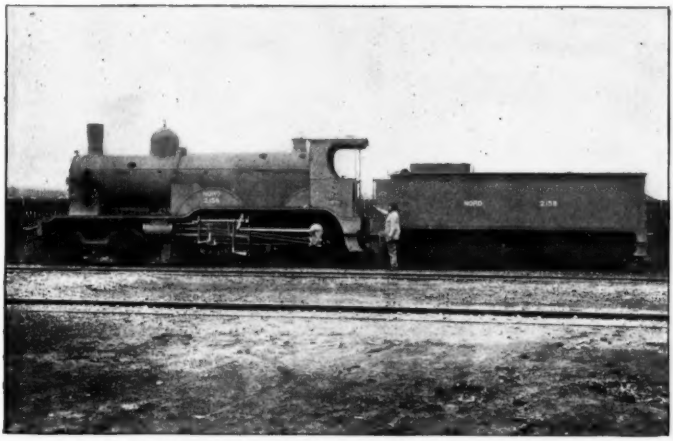


FIG. 3. FOUR-CYLINDER COMPOUND EXPRESS ENGINE. SUB-CLASS IV.
Latest type of Four-Wheel Coupled. Chemin de Fer du Nord.

they ran at high speeds, such as 70 to 73 miles an hour, for many miles together, travelling as smoothly as a single-wheeler and always arriving with cool bearings.

But one of their achievements, even in weight-pulling, was exceptionally fine, considering the speed. The engine was put on the heavy Lille express from Paris, which is timed to its first stop, Longueau, at 47.4 miles an hour. The train consisted of 24 coaches, carrying more than 700 passengers and a vast amount of baggage, the total weight being 340 tons. The journey was made in 6 minutes 43 seconds less than the schedule time, in spite of a signal stop which caused a loss of 4 minutes 37 seconds; the actual net time for the 79 miles was 88 minutes 40 seconds, representing an average speed of 53.3 miles an hour. Starting after the signal stop on an ascent of

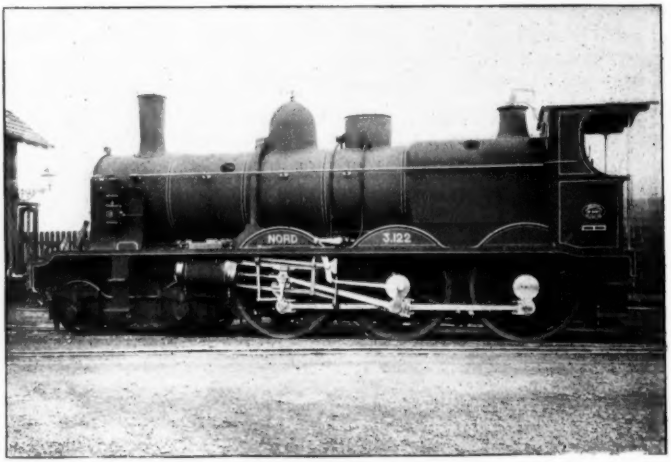


FIG 4. TEN-WHEELED FOUR-CYLINDER COMPOUND LOCOMOTIVE, CHEMIN DE FER DU NORD. NEW SIX-WHEEL COUPLED TYPE.

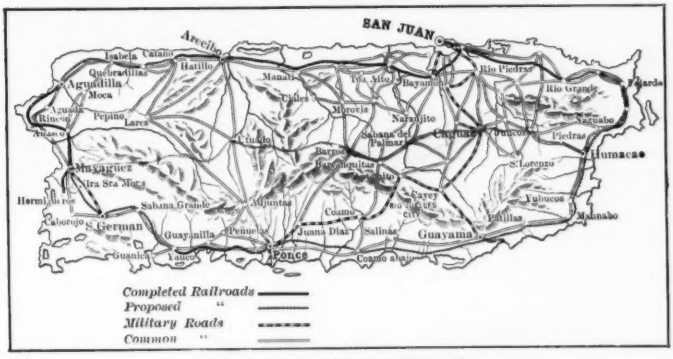
1 in 200, the engine, hauling 240 tons, attained 40 miles an hour in two miles from the dead start, with that load up that grade, and then steadily got up to 47 miles an hour, which was sustained to the summit. I have never before recorded so fine up-hill work. Going up the bank, 23 miles long, after Creil, the engine went steadily at 48 to 51 miles an hour, holding the faster rate to the end of the 1 in 250 and improving to 52 up the final length of 1 in 330, this speed actually rising as the summit was attained. I have no instances of such work, up-grade, in all my voluminous British records.

THE EXPLOITATION OF ELECTRIC TRAMWAYS IN PORTO RICO.

By Antonio Mattei Lluveras.

THE establishment of electric tramways throughout the island of Porto Rico, from east to west along the central range of mountains, would be desirable, easy, and relatively inexpensive. An electric line, starting from Naguabo or Humacao at the east end, touching the interior towns of Juncos, Cáguas, Aguas Buenas, Sabana del Palmar, Barranquitas, Barros, Jayuya, Utuado, Adjuntas, and Maricao, and terminating at Mayagüez, with branches from the main line to the villages along the coast, would serve, better than any other system, to move the rich products of those districts and to accommodate the great number of passengers who now have no means of convenient travel.

The coal problem, and many other expensive items of railroad building, would not be a consideration in the operation and construc-



MAP OF THE ISLAND OF PORTO RICO.

tion of such a tramway system, as there exist throughout the whole mountain range natural water powers available for any class of machinery. The many and powerful waterfalls having their sources in the mountainous inland region, and the rivers which run through this territory in various directions, seem to have been created by nature especially to aid man in the cultivation of the rich soil and the marketing of its products, which, because of the high altitudes and

necessarily heavy grades of high-roads, if these should be built, would otherwise be very costly. The interior of the island is extremely mountainous, as may be well seen from some of the illustrations. Around the entire extent of its coast, however, is a flat belt of rich lowlands, suitable for the cultivation of sugar and tobacco.

The highest village of Porto Rico, Aybonito, situated at an altitude of 2,300 feet above sea-level, is on the line of the central high-

THE TOWN OF PONCE, PORTO RICO.

way which runs from Ponce to San Juan. This fine highway, built originally by the Spanish government for military purposes, has no grade greater than 14 per cent., which would be the maximum also to be met with in the construction of a tramway along the mountain range.

The ballasting of road-beds, in whatever direction the lines might run, would cost but little, as there is more than enough material for this purpose on the ground; and throughout the whole extent of the proposed lines there is to be found wood of excellent quality for cross-ties. The labor required for such a construction is abundant and comparatively cheap, as the laborers in this region, accustomed to the hardest work, have never earned more than 75 cents a day (Porto Rican currency); and it would be an exceedingly easy matter to procure 2,000, 3,000, or 4,000 men for any kind of an enterprise.

Skilful stone cutters are easily to be had; and on the ground along the route is found an ample supply of stone suitable for bridges, culverts, and other constructions of a similar nature. In short, it will

not be necessary to seek elsewhere the materials for the construction of a tramway or railroad, as all, excepting the rails and other metal parts, are to be had along the mountain range. With abundant and well-distributed water power, from streams that do not fail even in the dryest seasons; with the materials for ballast and ties at hand; with labor cheap, good, and plentiful—the building of electric railway lines will certainly be attended with but little cost compared with the substantial profits that such lines may be expected to earn.

In the whole island, whose coast line measures 339 miles, there exist at present only the following steam railway lines, belonging to a French company:

One line, of one meter gauge, from San Juan to Camuy, with the following eight intermediate stations, Bayamón, Dorado, Vega Baja, Manatí, Barceloneta, Cambalache, Arecibo, and Hatillo. This is sixty-two miles long, and its operation produces an average income of $2,735 per mile annually.

Another line leaving San Juan on the north, passing through

BOAT LANDING AT PONCE.

Martín Peña and Rio Piedras, and terminating at Carolina, is 14 miles long. But the income from its operation is not so great, as another steam railroad runs in the same direction for half the distance, or to Rio Piedras, thus dividing with it the traffic of that region.

Still another line, 35 miles long, runs from Aguadilla to Hormigueros, with intermediate stations at the following villages: Aguada,

THE CUSTOM HOUSE WHARF, PONCE.

Rincón, the Corçica plantation, Añasco, and at the beach and city of Mayagüez.

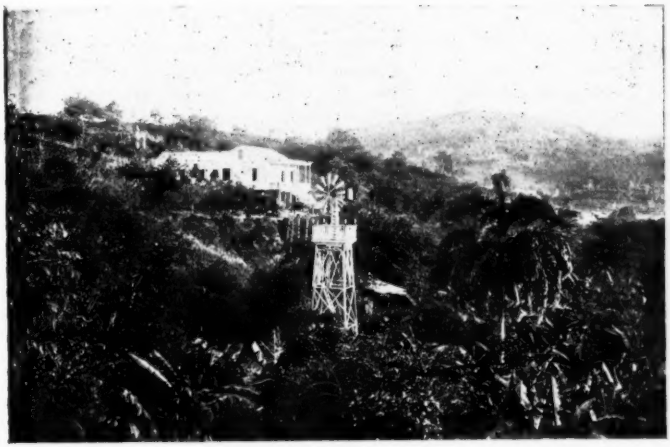
Another short line is in operation between Yauco and Ponce, a distance of 22 miles, with two stations on the line at Guayanilla and Tallaboa. This railroad has an average annual income of $2,760 per mile, but it should be noted that, because of the high freight rates, $2.25 per ton for a 22-mile haul, or ten cents per ton-mile, a great part of the freight-carrying between Yauco and Ponce is performed by ox-carts, in successful competition with the railroad. The freight rates of the ox-carts are not much lower than those of the railway, and the speeds are about the same. Besides this excessive charge, the railway does not offer the facilities which should obtain in this district, as it does not reach to the harbor of Ponce, where the great bulk of business is done. Bulk must be broken and the goods transferred, the transportation of merchandise and fruits from the railroad station to the harbor front by carts being a very costly item, as well as a source of great inconvenience.

The company which constructed these railroads had a concession from the Spanish government for building a line completely around the island, with a guaranteed interest of eight per cent. upon the capital employed in its construction; but the term of the concession was extended twice or oftener without a realization of the project,

although the company earned more than eight per cent. from the time it began the operation of the two small sections which have been actually finished. The island has not, therefore, enjoyed the expected benefits from the railroad, as so little of the line is constructed that only the towns between Camuy and San Juan are in direct communication. There exists also a railroad line from Mayagüez to Lares, passing through Añasco, which is the property of a private stock company; but it is operated only to the small town of Las Marías, the rest of the road being in course of construction.

Porto Rico has only one great highway, called the Central, which runs from the port of Ponce to San Juan, a distance of 83 miles, touching several points of little importance, such as Juana Diaz, Coamo, Aybonito, Cayey, Cáguas, and Rio Piedras. This highway is joined at Cayey by another of similar character, coming from Arroyo, the port of Guayamo, distant 22 miles. The greatest grade in either road is 14 per cent. But none of the towns not directly on the highways can make use of them, owing to the lack of branch roads leading to them. These main roads are indicated on the accompanying map by heavy dotted lines, the other roads shown being little more than horse tracks.

There are other highways in course of construction, such as those from Ponce to Adjuntas, from Rio Piedras to Rio Grande, and from San German to Maygüez; but none of them has yet been of much benefit, as they are finished only in short sections. Without doubt



A COUNTRY HOUSE NEAR PONCE.

they will be abandoned the day that better means, such as electric tramways, are furnished for transporting products.

It is this lack of communication throughout the island which curtails production, imposes stagnation upon the inhabitants, and impedes the development of many industries which could otherwise be established. The present difficulty of transportation is almost incredible. With no roads save those mentioned above, the moving of heavy articles is almost impossible. Coffee plantation machinery, and the like, when the single parts are too heavy for one mule, are put on a sort of sledge and dragged along the ground by oxen. Nothing can be more primitive, and at the same time more expensive, than such methods, as certain figures given below go to show.

The convenience of construction and the need for electric tramways throughout the island being thus established, it is easy to see that the movement of products to and from the interior must render satisfactory returns to any enterprise which gives to the people those advantages of easy communication and transportation required for the development of the country.

Official statistics for the calendar year 1897, which was certainly one of the least productive of the past decade, show that the exports of the island were as follows:

	Cwt.	Value.
Cane sugar	125,323,589	$ 4,007,999
Molasses	25,085,069	403,519
Coffee	51,097,823	12,222,598
Tobacco	6,181,771	1,194,318
Hides	822,108	71,852

There was produced, of course, a considerably greater quantity of each of these products, the difference going to the home consumption of nearly a million inhabitants. The total exports for 1897 are given in the Spanish "Estadística General" as $18,574,678.45.

Besides, there is a large production of minor fruits which do not figure in export commerce, although they are of considerable importance in interior transportation. If these fruits could be quickly and cheaply moved to the coast, for shipment to American markets, there is no doubt that a large and profitable trade in them could be quickly established.

The territory which produces the most coffee is in the high and mountainous parts of the island, along the central range, and here it is that the greatest need is felt for transportation facilities, the only existing means of communication being by horse roads or mule paths built by the residents. From the plantations where the coffee is gathered to the nearest towns on the coast, whence the berries may be

carried in ox-carts to the markets, carriage is effected, at the present time, on the backs of horses and mules, which can take only 200 pounds a trip. These same horses bring back an equal quantity of provisions and merchandise for the subsistence and necessities of the laborers and other inhabitants of the interior. For this transportation on horses and mules $1 a hundred pounds, each way, is paid from the points most distant, and 50 cents from the nearer points. Among these rich coffee plantations are some of considerable importance, such as the Esperanza of Pietri brothers in the jurisdiction of Adjuntas near the Guilarte range, which produces 3,000 to 4,000 cwt. at each gath-

A LANDSCAPE ON THE PORT ROAD, PONCE.

ering. This plantation employs a daily personnel of 350 laborers and pays $1 per hundred pounds for transportation to the town of Yauco. In the jurisdiction of Yauco the plantation Candelaria, of Pedro Olivari, produces 2,000 cwt., and pays a dollar per hundredweight for transportation. The plantation Mogotes, the property of Messrs. Pieraldi, also produces 2,000 cwt. of coffee of the very best quality, and pays 50 cents a hundredweight for transportation. The plantation Tres Hermanos of P. Cardie gathers and sends out 2,500 cwt. at an expense of 75 cents for transportation. The Santa Clara plantation, of Mariani's sons, gathers 7,000 cwt., employing a thousand men daily during the gathering of the fruit, and pays from $1 to $1.50 for transportation. The plantation of Sr. Vilella, in the jurisdiction of Lares, gathers some 4,000 cwt., paying $2 per hundredweight for

SUGAR HOUSES OF THE MERCEDITA ESTATE.

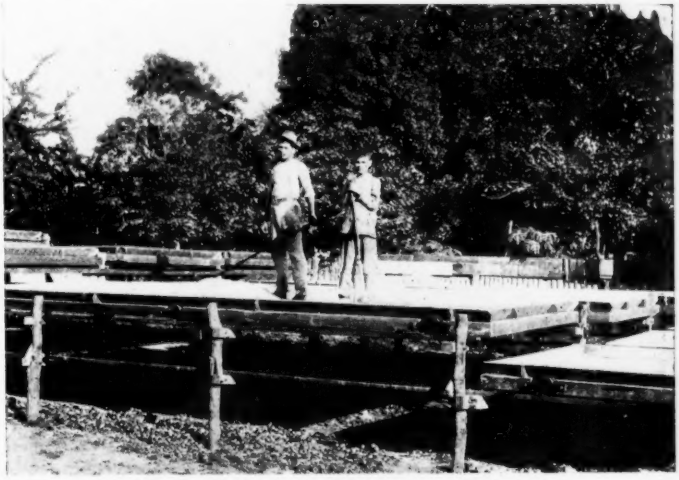
its transportation to Mayagüez. There are at least 300 plantations along the same range, side by side, in the short distance between Maricao, Yauco, and Adjuntas. One of the illustrations shows the process of drying the coffee berries in the sun, large sliding racks on which it is spread being employed for this purpose. The berries are spread out on the racks and raked over in the strong sunshine, the rails and rollers being simply for convenience in handling the racks.

Cane sugar, which is cultivated only on level ground and close to the coast, claims but seven plantations which produce centrifugal

ON THE ROAD FROM PONCE TO ADJUNTAS.

sugar. Of these may be mentioned the plantation Fortuna of the Gallart estate in Vega Baja; those of Jorge Finlay in Vega Alta, of Bianchi Pagan in Añasco, of Rodulfo Perez in Humacao, of Cintró in Yabucoa, of Borda in Canóvanas, of Rio Grande, and the Mercedes plantation of Sr. Serrallés between Ponce and Juana Diaz. The grinding and other houses of this plantation are shown in the illustration. There are several plantations in the island which produce about 16,000 cwt. of cheap brown sugar per annum, and there are many which for some time have been given over to pasture lands, but which could be reclaimed and would yield a large production, if intelligently and scientifically cultivated.

The transportation of sugar from the plantation to the nearest coast shipping point is generally effected in hogsheads of 15- to 16-



DRYING COFFEE ON A PORTO RICAN PLANTATION.

cwt. capacity at a cost of 20 cents per cwt. as a minimum and 32 cents as a maximum, except from the points where the railroads pass, very few to be sure, where it costs but $\frac{2}{3}$ cent per cwt. per mile.

Porto Rico, while essentially agricultural, is very backward in its methods of cultivating the soil, and in the quality of its sugar production—the chief element of its wealth. Besides the multitude of plantations of relatively small size which are devoted to sugar production, there exist great extents of level land, abundantly fertile, that can very easily be given over to sugar cultivation if large central grinding mills, working under economical conditions, are established.

The lowlands of San Germán, consisting of more than 45,000 *cuerdas*,* all very level, where there are now some 25 small cane plantations, could very easily be brought under one central grinding mill, the owners associating themselves for the purpose of bringing there the

A PORTO RICAN TOBACCO FIELD.

necessary implements for the improvement of the crop, while enjoying the further benefits to be derived from the introduction of improved machinery for the extraction of the juice. Here, again, is an opportunity for the application of electrically-transmitted power, generated from the torrential streams of the mountains which are nowhere far distant from the coast.

There exist also, in Guánica, some 20,000 *cuerdas* of swamp land, belonging to the government, which could be easily drained and made to produce 900,000 cwt. of sugar annually. Adding to this some 4,000 or 5,000 *cuerdas* included in the plantations Manantial, Fraternidad, and Desideria, which have irrigation plants, it will be seen that there could be established here a central grinding mill of considerable importance at a point near to the best port of the island of Porto Rico. This port of Guánica, endowed by nature with superior topographical conditions, has also been selected by fate as the site of the most important acts in the history of the beautiful island. It is the port from which the Spaniard, Juan Ponce de León, sailed

* A cuerda is about four-tenths of an acre.

on the 3d of May, 1512, to discover the island of Bimini and the Florida coast; and it was also the port selected by the American navy for the beginning of the occupation of the island, which was completed on July 25, 1898.

There is another great plain of 70,000 *cuerdas* in Guayama, which could be devoted to cane production, although in this part of the island irrigation would be necessary on account of the long droughts which prevail there. This could be obtained, however, from the Plata river, and more than one survey has been made with this in view. The fertile plains of Yubacoa, Humacoa, and Naguabo, which extend inland, by way of Juncos and Cáguas, are of such extent that ten or twelve large central grinding mills could be profitably established

A PALM HUT FOR DRYING TOBACCO.

there, as well as in the plains of Rio Grande, Carolina, and the large fields of Arecibo.

It is undoubted that the imports of the island are of no less importance than its exports in assuring positive returns to any electric-tramway enterprise devoted to the transportation of produce, as it is evident that nearly every class of articles for consumption must be brought from abroad. The home products of the island are not such as to support the population, exchange of the native sugar and tobacco against food products and manufactured goods being continually necessary.

The last official statistics present relatively respectable figures, and

it is advisable to have them in mind when speaking of the commercial relations of the country. The commerce of Porto Rico with the United States, notwithstanding the high customs duties, amounted, in 1897, to $3,749,815 of imports. The imports from other countries were as follows:

Spain	$7,152,016
Germany	1,314,603
England	1,755,754
Cuba	692,780
France	215,473
Other countries	2,977,622

This represents a difference of $2,240,652 between imports and exports, the excess being in favor of the former.

A detailed examination of the kinds of goods imported from Spain will show that nearly all will come in the future from the United States if their protection be established in this newly-acquired country.

The imports from Spain during the past year (1897) were classified as follows:

Cotton, wool, silk, horse-hair, metals, chemical and pottery products	$2,739,780
Wines, liquors, and oils	2,423,158
Animal products, employed in the industries, such as shoes, boots, gloves, lubricating oils, greases, etc.	1,160,242
Stationery and manufactures of paper	288,036
Woods and manufactures of vegetable products	279,076
Hemp, thread, and manufactures of vegetable fibres	242,620
Machinery and agricultural implements	19,104
Total	$7,152,016

The production of tobacco in Porto Rico also has an interesting future, and is bound to become the basis of a good business in the United States. Its cultivation there is easy and inexpensive, but it has recently fallen off because of the duties with which its export was burdened. One of the illustrations clearly shows the luxuriant growth of tobacco in a Porto Rican field.

The Porto Rican tobacco is equal in quality to that produced in the island of Cuba, and a large part of the famous tobacco which is exported from Havana and Santiago de Cuba under the name of "Vuelta abajo" is from Porto Rico, yielding large returns to Cuban enterprises. The manufacturers in Cuba buy the tobacco in Porto Rico, unstripped, and, after preparing the leaf, reship it at excessive profits which are due solely to the name "Havana tobacco." The

highest price obtainable by the cultivators of tobacco in Porto Rico never exceeds $28 a cwt. for run of leaf, and in these lots there is frequently found from 25 to 30 per cent. of superior leaf, which is afterwards exported from Cuba at $100 to $125 a cwt. simply because it appears to have been grown in Cuba.

Owing to the import duties which were placed on Cuban tobacco in Porto Rico two cigarette factories have been established recently—one in San Juan, called the "Cooperativa," and another the "Internacional" in Ponce. These factories have no competition in their line, and yield handsome returns, while giving employment to a large number of persons. They prefer to work tobacco from Cayey, Cáguas, Comerio, and Juncos, that from the plains of the Plata river being the best grown in the island.

Factories for manufacturing tobacco leaf exist in several towns of the island, particularly at Cayey, Ponce, Mayagüez, and San Juan, but the larger number of the tobacco-growers prefer to devote their energies to raising leaf for the preparation of chewing-tobacco, which they manufacture themselves. This is consumed by the laboring classes and yields relatively better profits, as it sells at 50 cents a pound.

These statements, based on actual figures, are sufficient to demonstrate that North American capital will find ready employment in Porto Rico for the improvement of interior communication, contributing to the agricultural and industrial richness of the island, and establishing the close relations which should exist between it and the American federation.

THE DEPRECIATION OF PLANT, AND ITS RELATION TO GENERAL EXPENSE.

By H. M. Norris.

IN accepting the invitation to supplement my article on cost-keeping with a second one, in which general expense should be made the chief subject of discussion, it was my purpose to give a digest of the practices of a number of metal-working establishments; and, with this end in view, I addressed the following letter to ten widely-known machine-tool builders.

I have in course of preparation an article on the depreciation of machinery, in which I should like to make mention of the practice of six or eight of our largest and best known firms.

The principal points that I wish to cover are as follows:

1. What do you consider the average life of a 12-inch, a 24-inch, and a 48-inch lathe; a 24-inch, a 48-inch, and a 96-inch planer; an upright drill, a milling machine, and a gear cutter—all of standard make—working under average conditions?
2. When do you consider that a machine begins to depreciate in value?
3. How would you figure depreciation on the above tools?
4. How do you regard small, loose tools, such as drills, reamers, taps, mandrels, milling cutters, etc.?
5. How do you regard belting?
6. How do you value your line shafting, including pulleys, hangers, and couplings?
7. How do you value your standard drawings?
8. How do you value your standard wood and iron patterns?
9. How do you value your standard jigs and fixtures?
10. How do you value jigs and fixtures that are used only occasionally?
11. How do you value such articles as vices, anvils, cranes, and chain hoists?
12. How do you value your work-benches, stock bins, and other shop fixtures?
13. To what do you charge repairs on machine tools?
14. Into how many items do you divide general expense, and what are they?
15. How do you apportion your general expense to the various articles you manufacture?
16. What is your general scheme of taking inventory?

But I find that I reckoned without my host, as will be seen from the following letters:

DEAR SIR,—The force in our office capable of answering intelligently such questions as you ask is always fully occupied, and just at the present time, owing to vacation season, is entirely too busy to take up and answer the large number of questions that you ask.

DEAR SIR,—While we are willing to show people every attention at our works, and help them in any way that we can to an understanding of our methods, we do not feel like going into all the details of our private business affairs in the way you have suggested. We say this to you in all kindness, and think you will appreciate the spirit in which we write you. In shops where people would be most likely to give such information it would probably be of the least value. At least, that has always been our experience.

Your first question, "What do you consider the average life of a 12-inch, a 24-inch, and a 48-inch lathe," we would reply to by saying that the difference between the extreme abuse of tools and the extreme care that is taken in some places would be very wide, and it would require considerable labor to get at the average wear and tear.

A short time ago we took a spindle out of one of our No. 6 screw machines that had been running about eight years. This spindle had, of course, hardened bearings at both ends, made of Jessop steel, and the fine marks of it made by the grain of the emery when it was ground were still on the spindle. This in the first place was a first-class spindle, and had been taken excellent care of. If the same spindle had been put in of some soft steel, running in babbitt or cast iron instead of phosphor bronze, and had also been very poorly cared for, it might have become useless in two years. This is simply to illustrate the difficulty in getting at what a fair average would be.

DEAR SIR,—We are in receipt of your favor of the 3rd, and regret exceedingly that we cannot comply with your request concerning our methods of proportioning our expense and other items to which you refer. We feel that this is, in a measure, private information that we do not care to have disseminated generally. We would like very much to accommodate you personally, but believe you will appreciate our position in this connection.

DEAR SIR,—We would have no objections to answering your several questions if we could do so verbally, but we cannot spare the time to answer by letter, as it would be too voluminous, and require too much explanation. If you should be in our neighborhood before your proposed publication, and will call upon us, we will be glad to discuss the matter with you.

DEAR SIR,—We reply to the questions in your favor of the 3rd inst. as follows, which we trust will be satisfactory to you:

1. Depends upon the care they receive; if they receive proper care, I should say one hundred years, or until it is profitable to change them for improved tools.
2. If not taken care of, say one week; if it is, it may be twenty-five years.
3. As above, most people make it 5 per cent. per year.
4. Depends on how much they are used, and what care they get.
5. This depends upon the kind, place it is used, and the work done. Our main belt, with some repairs, lasted thirty years.
6. 5 per cent off annually.
7. At cost several years ago, and have, since this item of cost was established, let it remain at same figure, with year additions of not less than $12,000 to $15,000.
8. At cost.
9. At cost.
10. At cost.
11. We first make a cost price, and carry the total along from year to year, and make no note of cost of repairs and additions.
12. At first cost, with no increase for many years.
13. General expense.
14. One item, including everything but labor and material.
15. Average 75 per cent. of the amount paid for machinist work, or about 17 cents per hour.
16. Work finished, wrought, raw, and in process, at cost; tools in shop, at cost when new, 5 per cent. discount each yearly inventory.

Yours truly,

THE PRATT & WHITNEY CO.,

F. A. PRATT.

MY DEAR MR. NORRIS:

* * * * * * *

It is very easy to figure up a large inventory account, increasing it each year, and at the same time be drifting toward bankruptcy at a breakneck speed; in other words, many companies who think they are doing a successful business and making money are, before they know it, hopelessly involved, and have to make an assignment. It may seem to you that our answers indicate that we are somewhat conservative, but that is a pretty safe side to be on. * * *

1. Depends on the ability used in the designing and manufacture and care in use. In cases of alleged "cheap tools" it is often most profitable to condemn them before starting.

2. High-grade tools most valuable when new. Depreciation begins quickly. Low-grade tools are in a sad state of dissolution before completion.

3. On the basis of above facts, allowing about ten per cent. per year for good machine tools.

4. As a necessary expense which soon pays for itself; so we don't count them in inventory.

5. Same as number 4.

6. We consider them as permanent fixtures, and inventory them as a part of the building.

7, 8, 9, 10, 11, 12. Charge to expense account and make no further note of them. (One exception in No. 11,—*viz.*, cranes we include in answer to No. 6.)

13. Charge ordinary repairs to expense account. Charge to the machine, if it is practically rebuilt.

14. Charge to expense account all items you cannot send a bill for, excepting such as add to the permanent inventory.

15. By percentage on monthly shop expenses.

16. Make generous reduction on previous year's valuation on old tools, and value new tools and supplies at cost.

Very truly yours,

W. R. WARNER.

(WARNER & SWASEY.)

DEAR SIR:—We are in receipt of your favor of the 3rd, and beg to advise you that, our shop being small, employing only from one hundred to one hundred and fifty men, we are unable to establish systems and carry them out as a large shop could afford to do.

We believe in many of your systems that are established in many of the large shops. We, however, understand that what a shop can do which employs one thousand men it would be impossible for a small shop to copy, as we do not want to spend five dollars to save one. In regard to your questions, we would state as follows:

1. We consider the life of all machines in our establishment at about ten years.

2. We consider the depreciation in value of a machine begins from the time it is started.

3. We figure the depreciation of a tool at about 10 per cent. a year, and that the life of the tool is figured at longer than ten years. The cost of repairs is such that it would equalize the total cost. If you have a tool in your establishment, and it has been there for twenty years and is in good condition, you will probably find that the repairs on this tool have been in that length of time fully as much as the cost of a new machine.

4. The small tools in our establishment are placed under shop expenses, with the exception of when the tool is for some special machine, in which case it is charged against the cost of that machine.

5. Belting is charged as shop expenses.

6. The line shafting, including the pulleys, hangers, and couplings, are considered as part of our plant.

7. Our standard drawings are charged as plant; drawings of special machines are charged to the cost of that machine.

8. We would say that our standard patterns are charged with plant, and patterns of special machines are charged against that particular machine.

9. We value our fixtures and jigs as plant.

10. Would say we have no jigs and fixtures which are used only occasionally, as special tools are very seldom built in this way.

11. Vices, anvils, cranes, etc., are charged as plant.

12. Work-benches are charged to plant; stock bins and other shop fixtures that are upon or attached to buildings are charged to building expenses.

13. The repairs on machine tools are charged to each tool and deducted from the 10 per cent. which has been allowed from the cost, as stated in reply to question number three.

14, 15, 16. We cannot answer unless going into a detailed letter, which we do not think would give you the necessary information. We would, however, at any time you are in Philadelphia, be pleased to have you call and ask any questions you wish to know.

Hoping this letter will prove of some use to you, we remain, Yours very truly,

NEWTON MACHINE TOOL WORKS, INC.,

H. W. CHAMPION, *Sec'y.*

A nation's progress is dependent upon the distribution of knowledge, and knowledge withheld is progress retarded. This is equally true of private enterprises, and I think it will be admitted that one of the chief essentials of progress, especially in the mechanic arts, is unselfishness—a willingness to exchange ideas, a broad and liberal policy, fostered by an *esprit de corps* which insures its own reward.

Profits of manufacture are not gained until interest on capital and loss by wear and tear of plant have been provided for. Many firms overlook both of these items, and fancy they are earning money when, in reality, they are living on their capital alone. Every neglect, or error, in this direction will, according to its extent, render calculations of cost and profit fallacious.

The depreciation of plant is an extremely troublesome problem, and it is probable that there is no phase of an industrial undertaking in which results show so wide a range of variations. This applies alike to drawings, patterns, jigs, fixtures, small tools, and standard machinery, and is particularly noticeable in the valuations placed upon plants of "going" concerns. It is, of course, impossible to formulate a rule whereby the annual shrinkage in value of a plant can be determined mathematically, but some general principles may be be kept in mind with advantage. Mr. Ewing Matheson, in his admirable book on "The Depreciation of Factories," says on this subject:

In regard to the proper rate of depreciation for machinery, there is, even in well-managed factories of similar class, a wide divergence of practice. Thus, in a new

factory doing a profitable business, private partners will, in their desire to be on the safe side, sometimes commence by writing off annually 10 per cent. from machinery of all kinds. Unless there be some apprehension of the plant becoming obsolete, this is generally too liberal a rate for fixed machines, unless it is neutralized in some other way. In other cases, the records of many years' working may show that 2½ per cent. is sufficient, because the machinery was good in kind and quality to begin with, partly also because the expenses of installation and of liberal repairs have been defrayed out of revenue, and partly because the machines have been moderately worked.

In engineering factories the rate which will probably meet the deterioration will generally be found between 5 and 10 per cent. Where the work is of a moderate kind, which does not strain the machine severely, and where the hours of working do not average more than sixty per week, 5 per cent. would generally suffice for machinery, cranes, and fixed plant of all kinds, if steam engines and boilers be excluded. Where there is a diversity of machinery and plant, and the past accounts of twenty years to refer to, it is not difficult to arrive at an appropriate rate and to make periodical revisions.

Mr. J. Slater Lewis states in this connection, in his exhaustive and extremely valuable work upon "The Commercial Organization of Factories,"

"There can be only two sound ways of dealing with the depreciation of the plant and building of mechanical engineering establishments,—*viz.*, (1) that of making adequate provision for the wear and tear of machinery and buildings by setting aside, out of revenue, a sum of money equal to the net depreciation, or (2) that of spending such money on plant renewals and repairs each year. If there are no profits out of which such provision may be made, or such renewals and repairs effected, then capital account will show a loss equal to the amount of the depreciation. It therefore follows that no dividends can be paid, and, probably, no interest debentures, until such sum has been set aside. Nor does this apply only to the current year, since it appears that no dividends can legally be paid in subsequent years, until capital previously reduced by depreciation has been made good out of earnings.

Although some firms keep their plant in first-class order, and effect such repairs from time to time as maintain it in good working condition, still it cannot be denied that all machinery is constantly being superseded by something more efficient, and that it is only a question of time in any case when it would be more economical to put some of it on the scrap-heap,—in fact, necessary to the very existence of the firm to do so. To only repair plant to make good depreciation cannot, therefore, be wise or sufficient. And yet to buy new plant regularly, or even at all in the early stages of a new concern, would, in order to comply with the requirements of depreciation, be absurd.

The soundest way to deal with depreciation is to keep all plant in thorough repair, and, *in addition*, to set aside, out of revenue, a sum of money which, in a given number of years, will purchase an entirely new series of machines. Any old machines that may be sold or scrapped in the meantime should be replaced out of the fund, and any new machine which is a virtual *addition* to plant charged to capital account. The cost of a new machine to replace an old one should be reduced by the value of the scrap, or by the sum for which it may have been sold.

It is obvious from the foregoing that the capital account plays no small part in the financial administration of a manufacturing establishment, and that general expense is not covered until provision is made for the loss by the wearing-out of the machinery of production,

to which must be added the interest on the cost of the entire plant, as well as on the working capital required by the business.

To facilitate a correct estimate of the valuation and subsequent depreciation of plant, it is expedient in many cases to separate assets into a number of distinct general categories, and to deal separately with each,—such, for instance, as the classification suggested in my former paper: A. Standard drawings; B. Standard patterns; C. Standard machinery and tools; D. Special tools, jigs, and fixtures; E. Line shafting and accessories; F. Office and shop fixtures; G. Belting; H. Miscellaneous.

The first on the list is standard drawings. How should they be valued, and how depreciated? Mr. Lewis omits the question entirely in his work, while Mr. Matheson says merely that "engineer's drawings should be charged to the particular work for which they have been made, but there may be a permanent value to be considered in the case of valuation for a change of ownership." At the Newton establishment "standard drawings are charged as plant, and drawings of special machines are charged to the cost of that machine." The Pratt & Whitney Company valued their drawings "at cost several years ago, and have, since this item of cost was established, let it remain at same figure, with yearly additions of not less than $12,000 to $15,000." Here we have three distinct, widely-varying practices. In the first, drawings are given no book value whatsoever; in the second, they are charged to, and, presumably, depreciated with, plant; while, in the third, they are treated as pure, unshrinkable capital—capital which, for some reason, is regarded as proof against the ravages of time with its "absolutely staggering" progress "in rendering existing machinery obsolete." Drawings are not merchandise. They are merely a means to an end,—a necessary evil in production, much akin to a salesman's salary.

A drawing serves two purposes; it shows, first, how work *should be* done, and, second, how work *was* done. It may be said to continue to represent value in the first capacity so long as it is used in production, while in the second capacity its value is practically nil. Drawings of special machines should, of course, be charged to the specific work for which they were made, for, unless they control future orders, they have no place on the books of the company. Standard drawings, however, are clearly chargeable to capital, not as assets from which a given percentage can well be written off annually, but as assets whose real value at any time can only be approximated by a system of debits and credits.

Those drawings which are the workman's sole guide will depreciate in value in proportion to the decline in the sale of the machine

they represent, while those which are replaced by samples, templates, jigs, etc., shrink in value at once, becoming useful as records only. The first may remain as an asset equal in value to their first cost, until diminished by decline in the manufacture of the articles they represent, reaching finally the class of records otherwise known as discarded drawings. When, however, a shop is equipped with a full set of modern, well-designed jigs and fixtures, where all tools are set and measurements taken from samples, the conditions are different, rendering a further division necessary. Standard drawings must be separated into "assembly" and "detail" drawings. The former retain their value as long as the machines they represent continue to be sold, while the latter retain their full value only until replaced by other shop guides, when, in all probability, they will be laid away, to be used at rare intervals as reference records. Drawings of jigs, fixtures, etc., should be charged as expense on the particular work they illustrate, and, after having been once used, should take their place with the special and discarded standard drawings, being written off the books at once—leaving as assets only those drawings which remain in constant use.

The next item demanding consideration is standard patterns, the vicissitudes accompanying an accurate determination of the value of which are so numerous and varied in character that most manufacturers have recourse to little else than guess-work, either in their appraisement or in their manner of dealing with depreciation. When seldom used, patterns have little value; if used often, they soon wear out. Hence one is frequently at a loss to know just what disposition should be made of them. Some prudent firms write off all patterns at once by debiting them to the first machine, or first lot of machines, made from each, while others go to the opposite extreme, and charge them to capital, with no regard to depreciation from year to year. Both systems have the advantage of simplicity, but simplicity is their only virtue. Patterns usually represent too much money to be so summarily dealt with. If added to capital and permitted to stand on the books of the company at cost, as it is by some firms, the business will show an inflated value, while to write them off at once is unjust to the original owners, as in a repetition trade it is frequently expedient to make a set of patterns which may have a value greatly in excess of the castings made from them the first year or two.

The value of a pattern may be said to depend upon three things, exclusive of accidents,—*i. e.*, its construction, the extent of its use, and the care with which it is handled. A strong, well-made planer pattern should withstand the making of a hundred castings before more than minor repairs are necessary; an engine pattern, a hundred

and fifty castings; and some simple patterns, such as are made in a snap flask, as many, perhaps, as a thousand. A pattern should never be permitted to remain in the sand longer than is positively necessary, and should always be carefully brushed after removal. It should be kept well varnished, and should be stored in a cool, dry place, protected from the rays of the sun.

There is always a natural reluctance to treat costly patterns as valueless; yet the moment one becomes obsolete, or in any way loses its usefulness, it is an incumbrance, however satisfactory it may be to look at, and should be broken up for fire-wood or scrap iron, as the case may be, rather than allowed to occupy valuable space, consuming money every time it is handled.

Patterns can seldom be satisfactorily treated in the accounts by the system of writing off a given percentage annually, and should never be valued or depreciated *en masse* by any system, unless they are made entirely of iron. They should first be classified according to the permanency of their capital value, and the cost of each accurately recorded in a pattern-book. Patterns for standard machines are always subject to more or less alteration in design, and are consequently worth less than those for standard gears, pulleys, hand-wheels, collars, etc., which, by their adaptability for any mechanism requiring such parts, have a much longer useful life. And patterns for jigs, fixtures, repair jobs, or to meet breakdowns, are of less value than either of the above. Then again, patterns for standard machinery made in large quantities differ vastly in value from those for machines rarely sold. It is obvious, therefore, that, in order to arrive at any considerable degree of accuracy, a separate and distinct rate of depreciation must be set for each class of patterns, and even then results should be checked by a complete re-valuation every few years.

In questions of this kind, the chance of a pattern becoming obsolete is a factor of considerable importance, and cannot be too strongly emphasized. Alterations in design not infrequently render a whole set of patterns obsolete before they have been used a dozen times. It is upon its *trade life*, therefore, rather than its possible life, that the valuation of a pattern should be fixed. Hence, the soundest and most effective method is to treat every pattern, or set of patterns, individually—on the assumption that a live, standard pattern has a value equal to the proportion of life still extant. That is to say, the present value of a pattern is to its original cost what the probable number of castings that will still be made from it is to the sum of the castings already made and still likely to be made, or, to express it arithmetically: Total likely castings: Castings still likely:: Original cost: Present value.

If a pattern costing $20 is likely to be wanted for, and will withstand the making of, fifty additional castings after having been used for one hundred and fifty, it is obviously worth only one-quarter of its original value, and should be written off accordingly—the proportion reading: $150+50 : 50 :: \$20 : x = \$5.00$.

Patterns chargeable to customers' orders do not, of course, add any book-value to the general stock of patterns, since it is assumed that they are of no general value, even though left unclaimed by the customer. Likewise, patterns for jigs, fixtures, special tools, attachments to plant, etc., are practically worthless so soon as they have been used for the purpose for which they were made, and should not, therefore, be permitted to figure as an asset. Further, patterns for parts of machinery that are furnished merely as repairs cannot be regarded as in the same category with those from which castings are much more frequently made.

Generally speaking, four classifications will be found sufficient to meet the requirements of the machine-tool builder: (1) patterns for jigs, fixtures, etc.; (2) patterns kept for the repair of *former* standard machinery; (3) patterns for *present* standard machinery; (4) patterns for such standard parts as are common to a large number of machines. Each of the classifications may be denoted by adding a figure to its distinguishing letter, as B_1, B_2, B_3, B_4. With such a classification before him, the pattern-maker will have little difficulty in charging the respective patterns to their proper class, as they are made. To make all patterns as if of one class, and afterwards to allocate them to separate heads, is, of course, possible, but highly inconvenient in practice.

Class No. 1 cannot be regarded as possessing any value whatsoever. The value of No. 2 depends entirely upon the nature and extent of the business, but should, in prudence, be written down very liberally. No. 3 had best be treated individually, as suggested above. Patterns of class No. 4, if made of iron, as such patterns usually are, may be regarded as of almost permanent value; little or nothing need be written off for their depreciation, providing, of course, that all repairs (varnishing, remarking, etc.,) are charged to general expense.

EDITORIAL COMMENT

In examining the engineering work of the month in technical literature, as recorded in the columns of The Engineering Index, a number of notable subjects attract attention; and, indeed, there is no better way to follow the trend of progress in the domain of engineering than to glance over the classified titles of the articles there presented.

* * *

In the field of electricity must be mentioned Professor Lodge's notable contribution to the development of space telegraphy, his paper before the Institution of Electrical Engineers, reviewed at length elsewhere, forming a remarkable account of the possibilities to be expected in the near future from the application of the magnetic-wave method. Other noteworthy papers dealing with the general subject of magnetic waves are also found, showing the continuance of interest in this fertile department of electro-physics.

Extending use of electricity as a motive power for traction must be noted; it is gaining favor both for elevated roads in cities and for overhead and underground trolleys in city and country, as papers from various parts of the world indicate.

* * *

In municipal engineering the vital subject of pure water supply is still the leading question. Filtration continues to be the favored method of removing injurious matter from drinking water, but the enormous consumption of water in many large cities, due in most cases to uncontrolled waste, makes this method of purification a difficult one to install. The bacterial processes of sewage purification, which continue to meet with favor and endorsement from the highest experts, may go far to remedy the difficulty of impure drinking water by removing much of the original pollution; hence the two subjects of water-supply and sewage disposal appear in close relationship.

The subject of automobilism continues to grow in interest, if the space allotted to it in the technical press may be taken as a guide. In fact, the automobile seems to be rapidly emerging from the "freak" state and entering into the sober realm of everyday work. To automobile cabs succeed self-propelled carriages for physicians, and to these again omnibuses, vans, and trucks; with the increased attention which is being given both to the motive power and the running gear of these vehicles, very practical results may be anticipated.

* * *

As might have been expected, the unique experience afforded in New York by the burning, during a high gale of wind, of a very combustible structure by the side of a modern tall building has called forth a number of articles upon fire prevention and fire-resisting construction, this subject being also discussed at length elsewhere in this issue of The Engineering Magazine.

Passing to other forms of structural work, the most notable descriptions included in the index are those of the completion of the great steel-arch bridge at Berne, and of the new bridge over the Rhine at Düsseldorf, while further accounts are given of the progress of the Alexandre III. bridge at Paris.

* * *

In the United States, especially, the engineering work which is likely to follow upon territorial expansion continues to furnish material for discussion, as is shown by articles upon the relations of the engineer to national expansion, together with others indicating more specifically the lines along which the earlier and more important undertakings may be expected.

Isthmian-canal projects continue to attract attention, the revived Panama scheme appearing as a competitor of the proposed Nicaragua canal. That the

isthmus will be pierced at some point now appears to be generally conceded, and the only questions for discussion are the still important ones of location, political influence, and the actual physical problems of construction.

Among hydraulic and electric power plants, the projection and execution of which form such an important feature in modern engineering, may be named the proposal to improve the navigation of the canal of the Iron Gates, on the Danube, by the construction of locks, and at the same time to utilize more than 20,000 h. p. of hydraulic power thus made available.

* * *

The subject of economy in generation and application of steam power always forms a conspicuous feature in mechanical engineering; the principal points being actively discussed at present relate to efficient combustion, in the case of steam generation, and to the mooted question of the wastefulness or economy of cylinder compression in the case of steam engines. The main factor in the waste of steam in engines having been detected in the form of cylinder condensation, the best method of diminishing this waste seems as yet undetermined. Multiple expansion seems rather to have lost favor as compared with superheating—or, rather, the united advantages of both are emphasized at length in papers of authority and value.

* * *

Recent investigations made by the German government into the diminution in the strength of copper at high temperatures confirm earlier researches in the same direction. They point to the advisability of using some other material where both stress and heat are acting upon the metal, as in the cases of high-pressure steam pipes, fire boxes, and the like.

In mining work the usual annual reports of mine disasters are found, while activity in the direction of safer mining explosives and more effective protection against firedamp continues unabated, Germany being especially active in this field. Increasing demands by iron manufacturers have led to the investigation of new ore fields, and iron ore will probably continue to be the theme of mining literature for some time to come.

* * *

The month has been busy in all branches of engineering, and but a brief *résumé* of the salient features can be here given.

In the Engineering Index, however, will be found direct reference to all the details, as reported by the technical journals of the world, and it is to the Index that the seeker for detailed information must be directed.

* * *

Viewed along economic lines, the crowding signs mark this as the age of trusts instead of the age of steel—which, however, suggests a closely kindred idea to the ear, if not to the eye.

The small investor has come out of his hiding; financial waters teem with fat and fatuous fish, scurrying madly into the dragnet of the promoter—to be squeezed for their grease.

The ways of trust promotion are simple; shut out foreign trade by a "protective tariff,"—stifle home competition by all combining together—mark up your goods to any extent dictated by your fancy, or your ideas of wealth and—there you are! All the world grown rich together. How beautiful!

But supply can not be absolutely cornered, nor demand autocratically coerced. Individualism can not be bound; someone always stays out—some stone is lacking in the projected arch—and, when the centering of over-confident promise and expectancy is taken out, the inevitable collapse follows. The promoter, who turned his inflated shares into cash at the height of the speculative madness, is not found in the ruins; the gasping investor is.

And this demoralizing and decadent movement will continue until its artificial source is destroyed—until the nation realizes that the "protection" now needed is the protection of honest and honorable direction, of skillful management, and of economical production—the protection of wide-spread trade, won by supremacy in a fair and manful struggle with the world and maintained in a world-wide competition under fair and equal conditions.

IT is not surprising that Mr. Warren's article on "The Fighting Engineers at Santiago," in our January issue, should have awakened an outcry in certain quarters. It is hard for many minds to realize that criticism may go hand in hand with warm sympathy—that a thing which was done marvellously well, may have succeeded in spite of grave defects, and that the wisest course is to look the defects in the face and, by mending them, make success surer the next time.

It is surprising, however, to find that few of Mr. Warren's critics know that most of his "charges" may be found clearly confirmed in the official reports of Admiral Sampson. This lends a particular interest to Captain Chadwick's communication, which many papers have taken as a reply to Mr. Warren, while it proves on examination, to be a confirmation.

The thanks of THE ENGINEERING MAGAZINE are most cordially extended to Captain Chadwick for his attention. It is a matter for further satisfaction that his comment "has the indorsement of Admiral Sampson." The essential thing is that the truth be made clear, by resort to the fixed facts and the highest authorities, and THE ENGINEERING MAGAZINE welcomes correction, where it is needed, as warmly as it does endorsement.

If the distance from the Morro to the Colon be forty-nine miles, instead of forty-five as Mr. Warren stated, it is right the fact should be brought out; but Captain Chadwick himself suggests a doubt as to the accuracy of the chart on which all the measurements are based. Mr. Warren's purpose, however, was not to establish any geographical details, but to serve the nation and the navy,—the bridge as fully as the engine room—by drawing serviceable lessons from the first actual test of the existing order under fighting conditions.

It is here that Captain Chadwick's contribution is most valuable. He strongly confirms Mr. Warren's argument—exactly in some points, generally in others, in which a different basis of measurement makes a close comparison impossible.

Mr. Warren says the forward engines of the New York were disconnected; Captain Chadwick confirms it, and the same thing applies to the Brooklyn. Indeed, it is so stated in Admiral Sampson's official report. Mr. Warren says, of the New York, "there were boilers disconnected, empty, and of course fireless"; Captain Chadwick agrees that there were—two disconnected and fireless, one of them empty. He says nothing about the steam pressure in the four which were fired.

In statements of speed, there are slight differences. Mr. Warren considers the race from start to finish; Captain Chadwick takes intermediate points. Thus he gives the New York's time "until she *slowed down* as she neared the Colon"; he states the respective speeds of the New York and Brooklyn as being 14 and 13.2 knots (Mr. Warren gave 11.06 and 13.06)—but Captain Chadwick's figures are between "points of departure taken after the chase was well begun," while Mr. Warren considers the whole time of running, including the slow getting under way due to the unpreparedness which is his principal theme.

Captain Chadwick says no salt water was put into the New York's boilers; Mr. Warren did not assert that there was. He does say, as the engineer of the New York has since said, that the Brooklyn's empty boilers were filled with sea water after the chase began, and he knows his facts. That it was true of more than one ship, in spite of the "circular order of Admiral Sampson's of May 29" which "covered this matter in great detail," is established by authority of Engineer-in-Chief Melville, who says: "There was trouble on several ships with collapsed furnaces due to the formation of scale in consequence of the forced use of salt water for extra feed." It is freely indicated in Commodore Melville's official report, and officially admitted as regards the Texas.

It is evident that, with this possible exception, there is no real controversy in matters of fact between Captain Chadwick and Mr. Warren. The significant part of the captain's statement is his extenuation of the facts. Coal economy, he thinks, was more important than readiness to use full power at any moment. There

would seem to be little cause for satisfaction in a policy which did, indeed, require the New York to withdraw less frequently for recoaling, but crippled her for the meeting with the enemy which was the whole purpose and expectation of the blockade. Mr. Warren gives the idea that the bridge officers did not realize, when they imposed these conditions of economy, how hard it would be to rise to the always-imminent emergency when it should finally come. In this connection his paper has its immediate value. It makes clear the difficulty which will be necessary and permanent so long as the ordering of the movement of the ship and the management of her motive power are in the hands of different authorities, neither of whom understands the work or the difficulties of the other.

From the nature of the case, the source of the information in Mr. Warren's article can not be disclosed. THE ENGINEERING MAGAZINE assures its readers that the information is beyond all question. With this reaffirmation of the accuracy of every essential particular, THE ENGINEERING MAGAZINE desires to couple a most earnest statement of its position. It desires to create no sensation, to excite no controversy, to make no charges, least of all to detract from the credit of any gallant officer or of the fleet which won so magnificent a victory at Santiago.

It desires solely to advance the effectiveness of the navy; to help every officer to a position of fuller command of his ship, in every phase of its structure and work; and to aid in establishing, throughout the entire body of officers of our navy, a standard of ability as high and as single as their devotion to duty and to the flag.

* * *

The Payne bill is in the House Committee on Merchant Marine and Fisheries and the nations are again invited to witness Uncle Sam in his great act of lifting himself over the fence by his boot-straps.

With fine irony, the bill is described as being "for the encouragement of the American merchant marine"; similar "encouragement" has nearly wiped the American merchant marine from the seas, and confined to home coasts the flag which used to be seen in every port of the world.

The sea is essentially free, and its mastery is won by struggle with opposing elements—not by coddling at home in the sun. As easily raise sailors on a mill-pond as ship-owners under protection.

While the House committee are debating amendments designed "that Mr Hogan's company might be included" or that the "Norfolk and Western railroad * * * should receive subsidies for twenty years," England is making more secure the carrying trade she has now.

When the United States adopt a free-ship policy, their ships will be sailed, and eventually built, as well and as cheaply as any. Until that time, American ship-building will exist as an exotic in an atmosphere which stifles the carrying trade.

* * *

An item in the technical press may sometimes journey for a long time and through devious paths. The Engineering Index provides a kind of identification bureau, where each new disguise is penetrated or *alias* noted. An amusing specimen of the journalistic waif, probably still upon its travels, is a paragraph describing an apparatus for electrically regulating the engines of a ship in a sea-way, so as to shut off steam if the screw is thrown out of water. Its original appearance, so far as is known, was in a French journal. From this it was taken, without credit, by an Italian journal. Another French technical publication adapted it from this, translating it again into French and reproducing the illustration. This time it was duly credited to the Italian paper in which it was found. From this French reprint an American electrical paper made a translation in abstract and, as the illustration was somewhat the worse for its many re-reproductions, had a new drawing made. Here again it was credited to the Italian journal. From its American contemporary still another French journal re-translated the paragraph into French and reproduced the redrawn illustration. The next appearance of the description is awaited with interest. Its journeyings, as described, occupied nine months.

THE BRITISH PRESS

Review of Leading Articles

Improvements in Space Telegraphy.

RECENT developments of methods of ether-wave telegraphy have given great impetus to the study of a variety of systems for space signalling or "wireless telegraphy." The history of the subject is very old, comparatively speaking, as experiments were seriously undertaken in Scotland about fifty years ago to obtain data for the construction of a system for telegraphing to and from America. This was, of course, years in advance of the first cable projects.

At recent meetings of the Institution of Electrical Engineers, papers were read by Dr. Oliver Lodge and Mr. S. Evershed, describing methods of magnetic induction telegraphy, and containing the outlines of a system that seems to be far more possible of extension and infinitely more adaptable to long-distance work than the Hertz-wave methods recently and loudly exploited. Dr. Lodge's paper is of great length, and contains an outline description of a new method of operating magnetic induction signals, descriptions of experimental work and apparatus, and analytical discussion of the principles involved. In brief, the system he proposes is the use of the mutual magnetic induction between two horizontal coils of large size. It is, of course, evident that the horizontal disposition of these coils, which amounts, in effect, to placing them in the same plane, halves the possible mutual induction of the system; but this arrangement introduces elements of great practical simplicity in the installation of such a system of signalling, and gives results that point toward the possibility of very-long-distance work with these means.

Through the coil at the sending station alternating currents of medium frequency are sent, in longer and shorter pulses as in the usual methods of telegraphy. At the receiving coil, which is similar to that used for sending, the circuit is "tuned" into syntony by the employment of reactive coils and condensers, across whose terminals a telephone, or some similar delicate receiver, is shunted. With this arrangement it is demonstrated that signals may be sent to any distance, provided enough copper and enough energy are employed in the sending coil. The calculation of the best proportions for the coils is not difficult, and the results are most striking. For example, it is calculated that, with a pair of coil circuits each about as large as England (say circles of 200 kilometers diameter) signals might be exchanged through a distance equal to the diameter of the earth. This assumes each coil to consist of one turn of copper wire about No. 0 gauge, and an applied voltage of 200 at a frequency of 1,000 cycles per second. Under these circumstances the current in the receiving coil would be about two microamperes, provided there were no absorption of the energy of the slow electro-magnetic waves by the conducting earth. This absorption, which is always in evidence, is, as yet, an entirely indeterminate quantity, but it is necessarily smaller with waves of comparatively low frequency, such as those just described, than with the high-frequency waves employed in radiant systems.

A number of most ingenious receiving instruments are described. Most of them are capable of being "tuned" into sensitiveness for a particular rate of vibration, thus becoming extremely sensitive for impulses of that wave-length and less so for accidental disturbances. Among these are tuning-fork telephones and sounding boards set in vibration by a moving coil telephone. From a point of a sounding board a stretched wire is led, the system of wire and board being tuned to responsiveness for the tone of the alternator employed. Upon the wire, and in circuit across the receiving condenser, is a very light coil in the field of a powerful magnet. This apparatus is said to be extremely sensitive and responsive.

Dr. Lodge's paper was evidently meant to be a general introduction to a further description of his recent work along this line of investigation. The later paper of Mr. Evershed is a description of the experiments conducted by himself and Mr. Cox along the same lines, and of the ingenious and beautiful instrument devised as a receiver. This is simply a vibrating loop of wire, adjusted to vibrate normally at the frequency of the sending circuit, and suspended in a strong magnetic field. The effects of even the faintest traces of current are, of course, cumulative in such an apparatus, and the vibrating loop may be employed either as a visual signal or to close a relay circuit. In this paper, also, a number of calculations are given for determining the size and power of loop circuits for this kind of space telegraphy.

Mr. Evershed's paper also describes some instruments and methods employed by himself and Mr. Cox in the British Post Office experiments in telegraphy to light-ships.

This work seems to be far the most important that has yet been done in the field of space telegraphy. It was soon evident that, whatever its possibilities for short-distance work, the ether-wave system of signalling could not be extended to really great ranges. If a simple and satisfactory system of long-distance signalling by magnetic waves, such as is proposed in these two papers, can be evolved, it seems likely that it will, in some measure at least, displace the direct-conduction methods using cables or long land lines. If, for example, it is possible to signal between the British Isles and the United States with circuits two hundred kilometers in diameter, the much lower cost of these, their simplicity and ease of repair, and the probability of a higher speed of working, should make cables obsolete in a short time. This is, probably, looking rather further ahead than the actual data advanced will warrant, but such a speculation is certainly attractive; it may also be very profitable. At the very least the system set forth is worthy of elaborate experimental work on a large scale. Its value in time of war would be beyond computation.

English and American Machine Tools.

THE subject of the relative merits of English and American machine tools has been discussed in many journals from various points of view, but it still seems very much alive, and a recent editorial in the *Engineer*, together with subsequent correspondence, brings out some points with an emphasis which cannot be misunderstood.

The most active advance of American tools in England has taken place in connection with the cycle industry, and at the cycle shows one of the usual exhibits has been that of the special machines from the United States engaged in the rapid and automatic production of bicycle parts. The depression in the bicycle trade, however, has caused an extension of the American tools to general purposes, and at the Stanley show this year the tools and operations exhibited were mainly devoted to general work.

"Instead of having the tools in motion at work on hubs, bolts, screws, and other parts for cycles, it was noticeable that a large number of them were turning out the requisites of general engineering establishments,—bevel wheels in place of sprocket wheels, rivets or large screws in place of gibs and small screws, and so on."

The result has been the opening of the eyes of many English manufacturers to the wide capabilities of these and similar machines, and, with the removal of restrictions in the way of their use, automatic machine tools and the various automatic devices as applied to ordinary machines must come into general and permanent use.

The fact that this is the case need not be construed into a condemnation of English tools of the older type, for in many respects and for many purposes the older tools will continue to hold their own. It is when numbers of similar parts have to be made that the advantage of the automatic machine appears, and one of the especial features of the American system of manufacture is that all work, so far as possible, is systematised, in order to bring it within the range of automatic machine work, this essential feature being kept in

view during the preparation of the designs.

Under these circumstances it is to be regretted that the English maker will not turn his attention to the design and manufacture of this class of machines.

"It was a fact which could have failed to strike but few observers that there were practically no tools of English manufacture exhibited at the Stanley Show, and at the National Show a firm which has always followed closely on American models had the best exhibit. Is it possible that English manufacturers cannot find time to devote some attention to this class of business, or is it that they still profess to despise American methods? If the latter is the cause, they would do well to undeceive themselves by an inspection of the American machines. It has been frequently stated that the imported article was weak and roughly made. A few years ago that was to a great extent true, but it is so no longer. American engineers do not stand still, and they have eagerly learned by experience. The consequence is that their tools are now-a-days at least as stoutly built as our own, and are as well finished, while in accessibility of their working parts, in ingenious automatic devices, in adaptation for rapid work, in convenience and handiness, they are far ahead of the productions of most British firms."

When the circumstances under which the tools of both countries were originally designed are considered, it appears most natural that such differences should appear. In England, until the question was settled by the termination of the engineers' strike, one man was not permitted to operate more than one machine, and machines which, by means of automatic contrivances, enabled skilled work to be done by unskilled men could have found no market. In the United States, on the contrary, such machines were eagerly welcomed from the first, and the idea that there was but a limited total amount of work in existence, to be parcelled out among the total number of workers, never found acceptance, experience having proved that the increased impetus which such machines give to industry results in wider opportunities for employment.

Now that the restrictions have been removed in England, such tools must undoubtedly come rapidly into use, and, if English tool builders will not furnish them, they must be purchased from abroad.

The matter is in the hands of the British manufacturer, and, in view of the clear statement of the case made by *The Engineer*, he cannot complain that he has not been duly warned.

Superheated Steam.

DURING the past few years there has been a decided revival in the use of superheated steam on the continent, but the practice has hardly extended yet to England; hence the paper of Mr. Paul Schou, read before the Northern Society of Engineers, and published in *Engineering*, giving the results of the latest continental practice, is especially worthy of notice.

Mr. Schou showed that the real reason why a higher economy than that now reached cannot be obtained with saturated steam is due to the nature of the saturated steam itself.

"The great drawback in using saturated steam as a driving power is that its range of temperature is very limited. On the one side, to raise the temperature of the steam we have a rapid increase of the steam pressure; and, on the other hand, we cannot lower the temperature of the steam below the temperature of the condenser.

"Quite apart, however, from these drawbacks, practice shows us that heat cannot be transformed into work without great losses. These losses take place principally in the steam cylinder, a part of the steam being condensed when coming into contact with the cylinder walls. The lower the mean temperature of the cylinder walls and the temperature of the steam leaving the cylinder, on the one side, as against the temperature of the admission steam, on the other side, the greater are the losses by internal condensation. The earlier the cut-off is, the more the internal losses increase, as the admission steam only heats a smaller portion of the cylincer walls,—that is, the mean temperature of the cylinder walls is lowered; conse-

quently, a larger percentage of steam is condensed during the expansion period. Through this exchange of heat between the steam and the cylinder walls, 20 per cent. of the heat is lost without doing any work, even in the best existing engines, but this loss often amounts to 50 per cent. and more, in ordinary engines."

Various methods have been used to diminish these losses, those most generally in use being the steam jacket, multiple expansion, and a combination of both.

Another method consists of the superheating of the steam, so that the ratio of sensible heat to total heat may be increased, while at the same time a considerable reduction of temperature may occur in the cylinder before reaching the point where condensation commences. This method is one of the oldest, and had its origin in England; but, owing to difficulties in the operation of the superheating devices, and to the action upon the lubricants in the cylinder, it has fallen into disuse. However, with the improvements in mineral-oil lubricators of high flashing-point, as well as the general advance of constructive methods, these earlier difficulties have been overcome, and in the case of the Schmidt superheated steam engine some remarkable results have been obtained.

The construction of the Schmidt engine is peculiar, there being a high-pressure cylinder in the rear of a low-pressure cylinder, the piston of the former being a plunger formed on the disk piston of the latter. The steam acts first on the high-pressure piston, and then passes to the space in front of the low-pressure piston, this space acting as a receiver, whence the steam passes to the annular space behind the low-pressure piston. This peculiar arrangement of cylinders serves to a great extent to prevent the loss of heat through the cylinder walls, because the heat taken up by the high-pressure cylinder walls is not lost, but serves to heat the receiver; besides which there are constructive advantages.

An engine of this design, using steam superheated about 150° C., has been in use for several years on rolling-mill work, developing from 400 to 750 h. p., with a steam consumption of only 8 3-4 pounds of steam per i. h. p. Numerous other installations of engines of this type have been made, and in all cases the advantages of superheating are evident.

The Schmidt superheater consists of a series of coils of tubes between one and two inches in diameter, arranged in the flue, so as to be heated by the escaping gases from the boiler, though in some instances the superheating is effected by an independent furnace.

A very important feature in connection with superheated steam, and one which has not been always fully appreciated, is the fact that with superheated steam engines can be operated at light loads with far less loss than that which occurs when saturated steam is used. This is due to the fact that, with superheated steam, cylinder condensation, the losses by which are necessarily much greater at partial loads, is prevented. For this reason engines operated with superheated steam are especially adapted for electric power plants where widely-fluctuating loads are to be handled.

Warship Machinery During Action.

THE conditions of existence in the machinery spaces of a modern warship in action are probably about as difficult as may be found anywhere in the world. "From the very first the stokeholds and engine-rooms will be closed down, splinter bars and covers fitted, and air supplied by forced draught and ventilating fans," says *The Practical Engineer*. Water-tight and air-lock doors are closed, and all communication between the bridge and engine-room and stokeholds is carried on by means of voice-pipes and telegraphs. It is extremely unlikely that any message will be distinctly heard in an engine-room during heavy firing, and, in addition, the voice-pipes and signalling circuits of most warships are so exposed that they would not last long under a concentrated small-caliber fire. The electric circuits must be maintained during battle at all hazards, as upon these depend light in the interior of the ship, and, in many cases, motive power

for gun-mounts and turrets. Provision must be made, though, for the use of hand-lamps, etc., in case the electric circuits fail. Air-compressing machinery must be kept running to supply torpedo tubes and pneumatic hoists. Unless the reserve feed tanks are full, the distilling apparatus must be kept going, while the duty of the feed pumps will be variable and severe throughout the action. The main engines will demand most attention, requiring probably two men at each set, one at the reversing engine and the other at the main stop and other valves. The fire and bilge pumps will require to be kept in operation during an engagement, and full pressure must be maintained on the fire mains to extinguish the fires likely to break out in various parts of the ship.

In cases where the main air pump is worked off the main engines, the loads on it will, of necessity, be heavy and severe, especially when starting at full speed after having been at rest for some time. In the main engine reducing-valves the fluctuations of the speed of steam will subject them to high and frequent changes of temperature, and hence of shape, possibly causing them to stick. The sticking of one of these valves would be a disastrous happening, and might place the ship in a very serious position. As cowl heads and windsails are likely to be thrown overboard or shot away, it is not impossible that smoke and powder fumes may be carried into the compartments below by the fans, —a very serious matter if the powder is of the smokeless, picric acid variety, as it would probably result in the suffocation of all hands below.

The boiler-room force also have a hard time in an action. On many ships there is a so-called protection of coal about their vitals. If the coal from the lower wing bunkers be exhausted, it will become necessary to trim from these upper protective coal spaces, thus exposing the trimmers, while, if a shell explodes in them, the fumes will fill the stokehold and probably set fire to the coal. If water is let into the coal by a shot, the bunker doors must be closed, and it is likely that the stability of the ship will be affected. As no ashes may be hoisted after the battle-hatches are down, except in ships fitted with hydraulic ash-ejectors, they may become a serious problem.

It will be seen from the foregoing that the engineer force aboard a warship have by no means an easy or safe berth in battle. It is probable that they are less safe, and certain that they are less comfortable, than their brethren behind the guns on the upper decks.

Long-Distance Electric Power Transmission.

THE literature of electricity possesses elements of the most diverse interest. Certain contributions to it have been of such value that important advances in civilization may be said to date from their appearance. The imagination has played its part, there being a variety of electrical literature best described as transcendental; and there have been facetious contributions, generally unintentionally so, but not the less amusing for that reason.

To the last category belongs Professor George Forbes's paper, lately read before the Society of Arts. It contains a proposition to transmit electrically energy generated at the Victoria Falls, on the Zambesi, to the Rand country,—in other words, to distances varying from 350 to 500 miles. It mentions, as easily and commercially possible, the lighting of Cairo from the first cataract of the Nile,—a distance of 400 miles. It even goes into details and gives figures, and, among other things, develops an entirely new idea in financing plants, proposing to use an indeterminate, but enormous, number of tons of copper wire, hung up in the heart of Africa, as a security upon which to borrow money at 4 per cent. The details are as amusing as ingenious.

It is assumed that, for a 400-mile transmission, all the power transmitted—say, 1,000 h. p.—can be sold at £50 per horse-power year. It is demonstrated that, under these circumstances, the plant will earn 40 per cent. annually above the mortgage on the copper, which, as the author ingenuously says, "may be taken away, if the company fails, and is an absolutely safe

security." It is assumed that 20,000 volts will be used, that the operation-cost of the generating plant will be £20,000 per year, and that nothing will ever happen to necessitate repairs. The copper—3,600 tons of it in this case—is to be borrowed for an annual interest payment of 4 per cent. on its cost,—about £10,800 a year. It is easy to see that, if the annual income is £50,000, there will be enough profit to pay about 40 per cent. dividend on the cost of the electrical machinery.

It is a beautiful proposition, but it has its disadvantages. If such an arrangement could be made for the use of the copper, and if the line miraculously supported itself, like Mahomet's coffin, without poles, along a costless right of way and without attention, to a region where people are willing to pay £50 per year for one horsepower; and if there were no depreciation, no wind-storms, no lightning, no earthquakes; and if power cost nothing at the generating end,—this would be a truly magnificent scheme. It would pay handsomely—until somebody should build a railway and haul into its district concentrated power in the shape of coal. Doubtless such a railway could obtain its capital for rails on the same basis as that proposed above for borrowing copper.

The Ventilation of Tunnels.

THE ventilation of railway tunnels has been, for a long time, a somewhat serious problem. As these tunnels have grown in length the absolute necessity for some form of artificial ventilation, in most cases, has been apparent, and numerous plans have been suggested and adopted with more or less success.

At a meeting of the Institution of Civil Engineers, Mr. Francis Fox presented a paper dealing, in part, with this subject. Assuming that the presence of 20 parts of carbon dioxide in 10,000 parts of air is the maximum allowable percentage, he showed a simple rule for calculating the amount of air necessary to be pumped into a tunnel per minute to attain this dilution, if the headway and coal-burning rate of the locomotives is given. This rule has been used with success in calculating the ventilation of the Severn and Mersey tunnels. Referring to the Metropolitan railway tunnels, in London, the author stated that the proportion of carbon dioxide in their atmosphere was as much as 86 parts in 10,000.

The long alpine tunnels present graver problems. The Mont Cenis tunnel, which is 8½ miles long and 26 feet wide, has suffered at times from a lack of proper natural ventilation; the middle section of this tunnel being at a higher elevation than its ends. At present an antiquated system of ventilation is used, compressed air to the amount of 70 cubic meters per minute being injected at points one kilometer apart throughout the bore. The effects of bad ventilation in this case are not only the discomfort, and even danger, of the men working in the tunnel, but also a highly accelerated corrosion of the rails in it, as much as 300 tons of new rails being required to replace the annual waste from this cause.

The St. Gothard tunnel is about one mile longer than that of Mont Cenis, and of the same lateral dimensions, but, unlike it, is nearly level from end to end. Natural ventilation has sufficed for it until quite recently, when the adoption of briquette fuel on the locomotives required the installation of a forced ventilation system. The Saccardo method was used, this operating by blowing a large volume of air into the mouth of the tunnel,—this stream of air working on the injector principle to carry a further induced current of air along with it through the tunnel. In the Pracchia tunnel, on the line from Florence to Bologna, this system was recently installed and has worked with great satisfaction, the tunnel before its installation being dangerous to human life on account of accumulated gases. It is thought that the same system will be selected for use in the two parallel twelve-mile tunnels under the Simplon pass.

There is another solution of the tunnel ventilation problem, not mentioned in Mr. Fox's paper, that is both radical and certain,—the avoidance of smoke and the necessity for ventilation by the use of electric locomotives. This solution was

adopted in Baltimore, with results so satisfactory that they should furnish a criterion for all future work along this line. In the Mont Cenis case, the deterioration of rails mentioned by the author is considerably more than sufficient to counterbalance the interest charges on an electric generating and conducting plant for the tunnel, and the locomotives; while the operation costs would be about the same in the two cases. It is to be hoped that the engineers of the new Simplon tunnel will recognise the homely fact that prevention is better than cure, and, instead of erecting a ventilating station, will build an electric plant and never allow their tunnel to be contaminated with the smoke of a locomotive.

The Bacterial Treatment of Sewage.

THE ENGINEERING MAGAZINE has already given space, both among its leading articles and in its review columns, to the increasingly important subject of the bacterial treatment of sewage, and now again there is occasion to give the matter further attention, in view of the recent paper by Mr. George Thudichum, presented before the Society of Engineers.

Mr. Thudichum shows that the experience which has been gained since the first introduction of the bacterial method has fully confirmed the correctness of the principles on which it is based, and he proceeds to show the conditions under which it may best be applied, and how, when necessary, it should be modified.

The three important questions which should be determined in any case are the available fall; the nature of the soil; and the possibility of the sewage containing ingredients which are hostile to microbial life. The available fall may decide whether the septic tank or the bacterial bed system shall be employed, and in gravitation schemes in which the total fall is less than four feet, the septic, or Exeter method possesses advantages, although pumping may be resorted to if economic reasons render it advisable. The nature of the soil may render the construction of bacterial beds advantageous, when, as is the case at Sutton, the clayey bottom renders the work very simple; but where the soil is light and porous the beds must be built on brick or concrete bottoms.

In regard to the character of the sewage, it has been apprehended that when it contains discharges from manufacturing establishments the bacterial action might be checked, but the experience of both Mr. Thudichum and Mr. Dibdin goes to show that such contaminated sewage can be successfully treated.

In a paper read before the Society of Chemical Industry it was shown that bacterial treatment was applicable to sewage containing considerable quantities of refuse liquors from many trades, including, effluents from tanneries, galvanising works, copper works, leather dressers, gas works, margarine factories, dairies, and distilleries. Taken as a whole, the experience of the last two years goes to prove that in the large majority of cases the manufacturing refuse which may be present in the sewage does not prevent the application of the principles of biological treatment throughout; whilst in cases in which preliminary precipitation or other treatment is necessary, the final purification can best be effected by means of the fine bacteria bed.

The Electrical Engineer.

IN discussing editorially a certain portion of Mr. Preece's inaugural address, *Engineering* calls attention to the use and meaning of the term electrical engineer in a manner which will bear examination, especially in view of the extending scope of the practice of many men already in that profession.

Mr. Preece, being himself an electrician, assumes that in the future every engineer will of necessity be an electrician, but if a knowledge of electrical science becomes a part of the ordinary equipment of the engineer, it will cease to be a distinguishing mark, and will no longer confer an appellation on its owner.

"Doubtless there will always be experts in electrical matters, just as there are in steam engines, but they will not be differentiated by name from the great mass of civil engineers. These must, in the future, be able to bring electrical science to bear on the problems offered to them for solution,

or they will find the field of their operations slowly and steadily narrowing. The great object of all engineering is the replacement of manual labour by mechanical power, and yearly this will become more pronounced. In most cases energy can be more readily controlled and directed as electricity than under any other mode, and hence this is the form to which the engineer must most often turn. Electricity is merely a connecting-rod to convey power from the point at which it is generated to the point where it is to be utilised, but it is a rod of such exceeding elasticity that in many subjects it enlarges the capability of the engineer enormously, and indeed opens fresh regions to him."

Not only is electricity necessary to the engineer, however, but experience has shown that the mechanical problems are frequently the most important and difficult questions in connection with the installation of electrical plants. The very fact that electricity has entered the vast domain of power transmission and distribution renders it necessary that all the details of power generation and application must be understood and controlled by the engineer in charge of the work, and while it is true that the two branches of electrical and mechanical engineering are fast approaching each other, it is also true that the mechanical engineer is far more likely to absorb his electrical brother, than to be himself absorbed. Again and again it has been stated by practicing engineers having to do with electrical work that the actual electrical portion of the work forms often only about 10 per cent. of the whole, the remaining 90 per cent. being civil, mechanical, hydraulic and general. The great central power stations are in themselves vast aggregations of boilers, engines, pumps, conveying machinery, and all the multifarious accompaniments of piping, valves, fittings, and other details. In other cases, the power station includes dam and weir construction, with the installation of turbines and all the mechanical questions involved in the regulation and distribution or hydraulic power. These facts alone demand that the engineer in general charge of the design and installation of such plants should be a mechanical engineer of the broadest grasp, and while it is becoming more and more necessary that he should be thoroughly familiar with the science of electricity, that is only one more accomplishment which should be added to those which he already possesses.

As *Engineering* well says: "Electric science is becoming one of the elements in the mental equipment of the profession, and to be ignorant of it, whatever be the special line adopted, is to be half educated. On the other hand, it needs to be dinned in the ears of the public, especially of that portion which is debating what to do with its sons, that electricity itself offers only a restricted career, and that a knowledge of its laws does not fit a man to pose as an educated engineer. During the past ten years we have again and again insisted that the basis of engineering was general mechanical knowledge, and that a youth who studied only electrical machinery was not in the way of becoming an engineer—not even an electrical engineer."

"Electric hoists, electric cranes, electric driving of tools, electro-chemical operations, and many other examples might be adduced to demonstrate that the problems of the day can neither be solved by the electrician who is not an engineer, nor by the engineer who is ignorant of electricity. Young men in the profession, and many who are not young, have need to lay Mr. Preece's warning to heart before they find that they are dropping behind in the race for fame and wealth."

THE CONTINENTAL PRESS

Review of Leading Articles

Water-Power Storage.

BEFORE the advent of electrical transmission it was generally thought impracticable to utilize any water powers except those which furnished a large volume and were in reasonably close proximity to commercial centres, where the power could be marketed to advantage. At the present time, however, it is found advantageous to harness even small streams, provided sufficient fall can be obtained; and in many instances streams comparatively insignificant in appearance are piped and led to impact or other wheels hundreds of feet below, and made most efficient sources of power.

In a recent issue of the *Elektrotechnischer Anzeiger*, Professor Intze, the recognized authority on the subject of storage reservoirs, discusses the manner in which many mountain streams whose flow is too irregular to furnish a satisfactory source of power may be impounded and regulated; and from experiences had in Switzerland and in Germany he details the elements which must be included in computing the cost of power obtained from such systems.

In order that satisfactory service may be obtained from an irregular supply of water, great care must be taken to secure accurate measurements both of the variations in flow and of the capacity of reservoir obtainable. In tropical countries there is usually a very definite division between the rainy and dry seasons, and it is necessary to provide a very large reservoir-capacity, but in central Europe experience has shown that with a moderate storage-capacity the flow may be regulated successfully, if proper care is given to the proportions of the plant.

The best method of studying any particular case is to plot the demand and supply as ordinates and abscissas, and construct the curve, the quantities being expressed in percentages of the mean annual flow. The maximum deficiency which may be expected may then be compared with the corresponding excess supply, and the requisite storage-capacity be deduced.

One of the earliest instances in Germany of a modern plant of such a system is that near Remschied, where the waters of the Eschbach, a small stream, are impounded and used for power and water-supply. This was planned in 1881, and since that time a number of such storage reservoirs have been constructed. Professor Intze gives the data of fourteen of these installations, with reservoirs ranging in capacity from 100,000 to 45,000,000 cubic metres, the latter being the reservoir for the 6,200-h. p. plant of the Urftthal, from which power is to be distributed from the waters of the Urft and the Ruhr to Mechernich, Düren, Eschweiler, Stolberg, Aachen, and other points, over distances of twenty to thirty kilometers.

Taking the experiences gained from these various installations, Professor Intze proceeds to compute the cost of power from a typical plant, assuming 7,200 working hours per year, and transmission distances ranging from twenty-five to thirty kilometers. Assuming an efficiency of 75 per cent., and allowing 10 per cent. for interest and depreciation, the cost of a horse power at the turbine shaft is found to be 32 marks per annum, while the cost of electrical conversion, transmission, and application is 47 marks, or a total of 79 marks per h. p. per annum. There is little doubt that, for a plant of corresponding size elsewhere, the cost could be kept within these figures.

There is every reason to believe that the interest which has been aroused in the development of hydraulic power is destined to increase, particularly in mountainous countries, such as Switzerland, Italy, and Norway, and the judicious use of carefully-proportioned storage reservoirs will render available for this purpose many streams otherwise too irregular to furnish satisfactory results.

The Influence of Heat on the Strength of Copper.

A VERY interesting series of tests of the strength of copper under various conditions has recently been conducted at the government testing laboratory at Berlin, by Professor Rudeloff, under the able supervision of Professor Martens; and a fully-illustrated report of the results is given in the *Mittheilungen aus den Königlichen Technischen Versuchsanstalten.*

The tests were undertaken to determine the following questions:

1. The influence of the chemical composition;

2. The relation between the chemical composition and the mechanical manipulation;

3. The permissible stress, both when annealed, and under various conditions of manipulation;

4. The strength of joints, either riveted, brazed, or both combined;

5. The influence of heat upon strength.

The most important portion of these tests was that which related to the influence of heat, since the extensive use of copper for fire-boxes, furnaces, boiler tubes, and high-pressure steam pipes renders it most desirable that the resistance should be determined under conditions similar to those of actual service.

By the use of the Martens 50-ton testing machine, in connection with special accessory apparatus for the purpose of maintaining the test-piece at a definite temperature, very reliable results were obtained, the delicate mirror extensometer enabling minute variations in length to be indicated very clearly.

The original report contains a great number of diagrams, plotted from the observed results, and showing plainly the weakening influence of heat. Without going too fully into details, for which the original paper must be consulted, some of the leading features of the tests may be given to show the general trend of the results.

For temperatures between — 20° C. and + 20° C. the diagrams show very little change in the strength or elasticity, but for higher temperatures a very marked influence was apparent. From 100° C. to 200° C. the strength was not materially affected under moderate stresses, but under further warming the weakening action due to heat became very apparent, and above 200° C. the strength fell off rapidly.

When it is remembered that a temperature of 200° C., or 492° F., corresponds to about 225 pounds' steam pressure,—a force which is now frequently attained and even surpassed in marine practice,—the inadvisability of using copper-pipe connections under such conditions becomes apparent.

So far as the influence of chemical composition is concerned, it appears that further tests, covering a greater range of specimens, should be made. At the same time there is reason to believe that the presence of other metals—*i. e.*, very small percentages of tin, zinc, iron, nickel, lead, etc.—enables the specimen to resist the weakening action of heat, the purest specimens suffering the greatest diminution in strength. If this should be established, it would indicate that some carefully-tested composition might serve better for resisting pressure and heat than does the pure copper.

The tests also give valuable information concerning the influence which different mechanical manipulations have upon the strength of copper, including hot and cold rolling, hammering, annealing, etc.; and, coming from so reliable a source as the Berlin laboratory, these important investigations will doubtless be accepted by engineers everywhere as valuable contributions to our knowledge of the strength of one of the leading materials of construction.

American Industry as Viewed from Austria.

THE active entrance of American trade and the products of American industrial establishments into the business of the continent has led the American methods of production to be considered with some interest.

The causes of the development of American industries formed the subject of a long address delivered by Herr

Karl Wittgenstein before the Austrian Society of Engineers, and printed in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines.*

Speaking from the standpoint of an Austrian, but possessed of a knowledge based on personal observation in various parts of the United States, Herr Wittgenstein gives some interesting information as to the conditions under which the competition between America and central Europe at present exists. Since Germany has made the greatest advances in industrial matters during recent years, he takes the German empire in comparison with the United States, and shows many interesting facts as to the different conditions surrounding labor and its products in the two countries.

Without going into the extensive statistical matter presented by Herr Wittgenstein, we may give the deductions which he makes, and upon which he bases his argument. In general, he shows that, taking into account many different lines of industry, the wage of the American workman is about double that of the German. Although the cost of living is greater in America, it is not proportionally so, in comparison with the higher earning-power. In America, on the contrary, food is less costly than in Germany, while clothing costs about the same, and dwellings alone are more expensive.

Although the American workman earns more than the German, this does not retard industrial enterprises, but, on the contrary, stimulates them, for these larger earnings are not hoarded, but spent in such a manner as to increase the internal trade of the country. But, if the American wages are higher than the German, the work is conducted in a far more intensive manner. Herr Wittgenstein aptly compares the American mechanic to the engineer of a fast express train, with mind and body strained to the utmost tension, while the German in many instances is more like the driver of the old post-coach. He affirms it to be the universal verdict of German mechanics who come to America that the pay is good, but the pressure of work far greater than at home.

After tabulating many statements of the relative growth of American and German industry, Herr Wittgenstein makes a brief historical *résumé* of the progress of industrial operations in America from 1600 down to the present time. Much of the early development was shown to be due to the efforts to exploit a new country as well as to the distance from the mother country and the necessity of reliance upon local resources. These conditions, however, also obtained in the Latin colonies; but in the latter the influence of individual initiative was subordinate to that of official and governmental control and direction. In the Anglo-Saxon colonies the spirit of individual freedom, sustained by the fundamental principles of English common law, enabled the individual characteristics of the race to develop almost to an unlimited extent, the contrast with the Latin colonies in this respect being especially a matter for comment.

Coming down to the present time, Herr Wittgenstein discusses the influence of education, showing the immense advantage possessed by the workman who has a good general education over the man who must always feel his inferiority in this respect. One of the greatest hindrances to industrial progress, he rightly says, is the abject European peasant, who, feeling his ignorance, stands with hat in hand before the proprietor, the parson, or the petty official, and is utterly without the stimulus to individual effort which can come only with the sense of civil equality.

Industry is not a determinate science, and cannot be subjected to mathematical laws. The successful man not only must possess technical and commercial ability, but must also have trained foresight into possible changes of policy or introduction of new methods, as well as that grasp of the entire industrial situation which can come only with speculative freedom of thought and action, such as exists nowhere else to such a degree as in America.

That such liberty and such methods often lead to undue speculation and to the precipitation of commercial crises is freely admitted, but such occurrences are not as

great a drawback to progress as is the clog of governmental supervision and bureaucracy. In this respect Herr Wittgenstein differs wholly with the admirable presentation of the other side of the case by Mr. Magee in his paper on "America and Germany as Export Competitors," given elsewhere in this issue. In regard to the value of labor-saving machinery and methods he is fully in accord with Mr. Orcutt, who also discusses German and American industrial methods in this and other issues of this magazine; and it is only by a thoughtful comparison between these views, from various standpoints, of this many-sided subject that a true grasp of the present situation can be obtained.

Power-Development at the Iron Gates.

IN the improvement of the navigation of the Danube at the Iron Gates the method adopted, fully described in these pages at the time, consisted in the canalisation of the stream by the side of the rapids, quiet channels of uniform slope being provided instead of the difficult and dangerous navigation of former times.

Even with these improvements the current in the canals is swift, and, in consequence, the ascent of the stream is slow and tedious, especially for heavily-laden vessels and tows. It has therefore been proposed to place locks at the lower end of the canal at the Iron Gates, thus not only overcoming the resistance of the current to upward navigation, but also providing a fall of 2.75 to 4.30 metres available for power, according to the condition of the river.

These proposed improvements are fully discussed, with profiles and plans, in an article in the *Zeitschrift des Vereines Deutscher Ingenieure* by Professor Hans Arnold, and the advantages of the plan are clearly set forth.

Since the opening of the canal to navigation on the occasion of the Hungarian millennial celebration in 1896, it has been evident that additional works must be undertaken to make the navigation of the Danube past the Iron Gates a commercial success.

The rapidity of the current in the canal offers a greater resistance than is desired, and the only way to diminish the current, other than the use of locks, is to prolong the canal up stream, dredging the bottom to reduce the slope, and incurring great expense and loss of much time.

The plans shown by Professor Arnold, however, not only provide for the avoidance of this expense by the use of locks, but also include the construction of a great power house to utilize the overflow water. This power house will be 522 metres long, divided into six sections, containing ten turbines of 400 h. p. each, upon vertical shafts carrying polyphase electric generators, the whole forming a plant capable of delivering from 20,000 to 24,000 h. p., according to the height of water.

The locks, which are to form an important portion of the improvements, will be 20 metres wide and 180 metres long, large enough to admit one steam tow boat and two large barges, and the elevation of the water-level in the canal will enable a depth of water of 3.1 metres to be maintained.

The completion of these important works, therefore, will not only render the navigation of the lower Danube far more practicable and profitable than has heretofore been possible, but also convert what has been the main cause of expense into an important source of revenue; moreover, it is by no means improbable that the presence of this large available power plant will develop industries which will in turn build up the river traffic.

Alternator Regulation.

THE alternating current has met with continually-increasing application in the arts, largely on account of the simplicity of the apparatus concerned with its production and utilization, but many engineers still exhibit a decided preference for the direct current. They acknowledge the superiority of alternating currents for motor power and lighting purposes, but decry their universal use on account of three disadvantages possessed by alternating systems,—the troubles occasioned by capacity and self-induction in lines and apparatus, the necessity for synchronous

speeds in alternators coupled in parallel, and the impossibility of connecting these machines in series.

A solution of these problems, remarkable both for ingenuity and simplicity, was proposed by M. Maurice Leblanc in a recent paper read before the Société Internationale des Electriciens. Referring to the three objections to the use of alternating currents, the author shows that the necessity for the practical elimination of wattless currents in alternating-current generators leads to a wasteful design in these machines, and an inefficient utilization of the materials of which they are constructed. In induction motors, also, the short air-gap, required for the double purpose of reducing magnetic leakage and keeping the power-factor high, is impracticable in large sizes. As to the question of synchronous driving, there is always a possibility of some form of "electro-mechanical resonance," or "hunting," on the part of one engine, impossible to foresee, and causing dangerous stresses in various parts of the system.

The Thury system of power-transmission by direct current at constant intensity of flow is limited in practice by difficulties of commutation. An alternating system of this character would be ideal, on account of both safety and simplicity, but it would absolutely require the possibility of connecting the generating machines in series.

The proposed system enables alternators to be compounded for constant voltage or constant current, to be connected in series or parallel, and to be constructed with a high armature self-induction, thus assuring stability of parallel operation, while at the same time permitting the greatest economy of material in their construction. The system is, briefly, as follows:

A special exciter is provided, having a speed and number of poles such that it runs synchronously with the alternator. Some form of mechanical connection between the two is requisite, the simplest being when both machines—generator and exciter—have the same number of poles and can be built upon the same shaft or directly coupled together.

In the exciter the rotating part consists of two similar Gramme rings, each wound with a number of regularly-spaced coils equal to that on the armature of the alternator, and bearing to one another the same phase relations as those between the coils of the principal machine, if this is polyphase. By means of slip rings and brushes the coils of one of these ring armatures are connected in series with the corresponding coils of the alternator, while, through a similar arrangement, the coils of the other ring armature are shunted around those of the alternator and the first ring.

Over the cores of the two Gramme rings is wound an ordinary direct-current winding connected to a commutator. On this are brushes, equal to the number of poles. The composite armature thus formed turns in a field consisting of two iron rings surrounding the cores of the two armature rings. These field rings are so proportionate that the magnetization of that one surrounding the series-connected part of the armature is far from saturation, while that of the other is strongly saturated when the machine works under normal conditions.

Over the two field rings is wound a continuous winding of as many turns as that on the direct-current layer of the double armature. To this are connected, through the field coils of the alternator, at points equally separated, leads from the commutator brushes. As the number of turns and current in this winding and that on the rotating parts of the machine connected to the commutator are equal, there is no magnetic flux produced by the rotation of the direct-current parts of the machine, the system being in equilibrium.

The alternating-current coils on the Gramme ring sections of the composite armature are so connected that they produce a rotating field, turning in a direction inverse to that of the mechanical rotation. Hence there is produced, by the alternating current, a stationary magnetic field, and, the armature reactions being entirely balanced out by the construction described above, the resultant voltage at the brushes and the magnetizing current

supplied to the alternator fields depend only upon the output of the alternator and the setting of the exciter brushes.

Since, by this method, the field excitation of the alternator may be governed entirely by its output, it can be compounded either for constant current or constant voltage. By the addition of a "squirrel-cage" winding on the inner surface of the stationary rings, when the exciter is used with a single-phase machine, there is a tendency in each of the Gramme rings toward the production of two simultaneous rotary fields. That which turns in the direction of the mechanical rotation is destroyed by the "squirrel-cage," leaving the other, fixed in space, to operate as described above.

It is evident that these exciters will operate as synchronous motors, and can, therefore, be adapted to any alternator and set up in any convenient place.

Space does not permit a description of M. Leblanc's experimental verification of the value of this variety of excitation. It is evident that machines so equipped will lend themselves to a variety of uses, and that, despite the more costly construction of the exciter, the alternator may be built with a far higher armature self-induction and a consequently more economical use of materials.

But it is in the possibility of the use of such alternators as single-phase synchronous motors, and in the series connection of generators, that M. Leblanc's labors will probably bear the most valuable fruit. This method of excitation renders the Thury system possible with alternating currents, and may go a long way toward solving the difficult and fascinating problem presented by the adaptation of single-phase motors for traction purposes.

Telegraphing with Light and Electricity.

SEVERAL months ago there were noted in hese columns the experiments of Professor Zickler upon the use of the ultra-violet rays to produce an electric discharge at a istance, thus enabling intelligence to be ransmitted. The early experiments included but a small range of distance, and were intended rather to demonstrate the principle than to serve as a working system. A later communication in the *Elektrotechnische Zeitschrift* gives the results of further experiments.

The original trials demonstrated that, when the ultra-violet rays fall upon terminals which are just too far apart to permit an electrical discharge, the action of the light waves enable the discharge to occur, and hence, by use of screens of rock-crystal and glass, the interruption of the violet rays may be adapted into a means of communication.

In the later experiments a Schuckert projector was used, the source of light being an arc lamp operating at 47 volts with a current of 60 amperes, the carbons being so screened that only the reflected rays from the parabolic reflector are used, the direct rays being cut off. The receiver was made more sensitive to the action of the rays by allowing a less complete vacuum in the tube,—a vacuum of 340 mm. of mercury being used, instead of one of 200 mm., as in the former researches.

With this improved apparatus the distance over whlch intelligible communication could be maintained was increased from 50 metres to 1.3 kilometres, and the experience thus gained showed that further extension of the distance may be expected from additional improvements.

It is too early yet to speak definitely of the possibilities of this mode of communication, but there is reason to believe that for certain purposes this ingenious system is well adapted.

The New Bridge at Dusseldorf.

NEARLY two years ago there was given in these columns an account of the plans for the new bridge across the Rhine at Düsseldorf, and the peculiar conditions under which the work was undertaken were then stated at length. The completion of this important engineering work is now the occasion for several articles in the technical press, and from illustrated descriptions in the *Zeitschrift des Vereines Deutscher Ingenieure* and the *Oesterr. Monatsschrift für den Oeffentlichen Baudienst* some interesting features of the bridge are obtained.

In brief, the bridge has been constructed by a private corporation, and, in consideration of this construction, there has been granted to the company the right for an electric railway from the centre of the city, across the bridge, to Crefeld, some thirteen miles away, together with the collection of tolls on the bridge, and a title to more than nine hundred acres of reclaimed land on the left bank of the Rhine.

The structure itself is a noteworthy example of a type of bridge used in numerous recent cases in Germany, consisting of the braced arch with suspended roadway; at Düsseldorf there are two main spans of 594 feet each, with three smaller spans on the left bank, and one on the right, making a total length of more than two thousand feet. The construction of the masonry piers was begun in the summer of 1897, the pneumatic method being used, the foundations extending to a depth of about forty feet below the surface of the river.

The method adopted for the erection of the great arches presents some features of interest, and is well shown by photographs taken during the progress of the work. As it was required that the main channel of the Rhine should be kept unobstructed, it became necessary to construct the false works with a truss of 164 feet span over the channel, the remainder of the construction works being supported upon piles. The false works were carried up to a level above the highest point of the steel arches, and traveling gantry cranes were supported on the trackway thus provided. The facilities thus provided, together with the entire readiness of all material, made it possible to erect one of the great arches in the short time of six weeks, and thus permit the false works to be removed and the full waterway to be opened again.

One of the important points to be obtained by the construction of the bridge was the connection of Crefeld with Düsseldorf by electric tramway, and the improved communication thus secured between these two important industrial cities cannot fail to be of benefit to both. The construction company will be able to reclaim nearly one thousand acres of land on the left bank of the Rhine, all of which is to be improved and developed, while on the right bank the city of Düsseldorf is to construct a quay and promenade which will make it a rival to Cologne.

The total cost of the bridge, not including approaches and land damages, was 3,800,000 marks, or, including these additional charges, as well as interest, about 60,00,000 marks. As an engineering work the Düsseldorf bridge reflects great credit upon Professor Krohn, by whom the design and computations were made, and also upon the Gutehoffnungshütte, of Oberhausen, by whom the structural work was done and the erection conducted.

Water-Power Legislation in Italy.

THE development of the water powers of Italy by electrical means has been greatly hindered by a variety of singular legislative difficulties and the continuance of old laws, made before it was possible to generate power in one place and utilize it in another. The subject is treated very fully in an interesting report presented by Signore M. Vicarj and R. Pinna to a recent meeting of the Società Economiche, and printed in full in *l'Elettricità*.

The annual payment by Italians to foreign producers of coal is stated by these authors to amount to more than a hundred million lire. The country is full of streams of rapid descent, affording abundant water power. Of these a few have been developed, but the development does not keep pace with the growing requirements of Italian industries. In 1895 eighty-two concessions were made, for the development of 16,600 h. p.; in 1896, seventy-eight concessions, for 36,900 h. p.; and since then the demand for concessions has grown. In spite, however, of the increase of these authorizations for the exploitation of water powers, the annual consumption of coal in Italy has steadily mounted. It is to be remembered that no coal is mined in Italy, and that all that is used there comes from outside. In 1896 the importation amounted to 4,081,218 metric tons. The next year it increased

to 4,259,646 tons. In addition to the increase in importation, the price of coal has also risen, and Italian engineers find themselves confronted with an absolute necessity of at once making use of the natural source of power afforded by the snows of the Apennines and the Alps.

But it is at this point that the difficulties begin. Each local district guards jealously its own supply of power water. The possibility of using the waters of one neighborhood for the development of power to be utilized in another place,—often to the actual detriment of the region in which it is generated—has caused an active opposition to most of the projects for water-power development. Concessions for the use of power are given by the district or provincial council, the right of private property in water-power not being recognized in Italy. When one of these concessions is sought, the promoters of the enterprise find themselves confronted with a variety of regulations and requirements,—features of ancient laws, still in force, but made with no reference to present conditions. If it is proposed to undertake the transmission of power by electricity to a distance, local opposition at once asserts itself, for the reason mentioned above. Further, the concessions, while limited to thirty years, are renewable indefinitely for similar periods, and this state of things has precipitated a warm discussion of the endless question of private versus governmental ownership and control of these works.

The New Reservoir at Madrid.

IT is customary in many countries in Europe to construct roofed or covered reservoirs for the double purpose of preventing any contamination of the contained water and avoiding the heating of the water through contact with the air and sunshine. It has been the custom to build these reservoir roofs sufficiently strong to stand the weight of a thick layer of earth, which is used as a non-conducting covering. In the new reservoir under construction at Madrid, of which an account appears in *Revista de Obras Publicas*, a different system is adopted, which seems to promise decidedly better results.

The roofing consists of a double system of brick arches, one above the other, including between them an air space. These arches are supported by brick walls and pillars, which serve also to divide the reservoir into a large number of independent cells, and are very flat. Those of the lower roof are constructed of a single course of brick, laid in neat Portland cement mortar and given a surface dressing of the same. The upper roof arches are two courses thick, and constructed of the same materials. The span of these arches is about thirteen feet, their abutments being stout steel I-beams running from pillar to pillar.

The retaining walls and all the division walls and pillars are built of Madrid brick, not of very good quality, laid in Portland cement mortar and surfaced with concrete. Tests of the arches mentioned above showed that those of a single course of brick were able to sustain, without deformation or injury, loads of three tons per square metre of their upper surface.

This reservoir will be the largest of its type in existence, its capacity being 1,665,000 cubic feet, or more than twice as great as that of the Saint Cloud (Paris) covered reservoir. The work of construction, which was begun some time since and interrupted after the completion of the excavations, has been placed at contract, and the resulting cost of the finished work shows that this will be the least costly reservoir of the covered type in existence. The old reservoir at Madrid now holds the record for low cost, its construction having required an expense of only 17.76 pesetas per cubic metre of useful capacity. The new one will cost a little less than 13 pesetas per cubic metre.

Nothing is said as to the methods to be used in removing deposits of mud from this reservoir. Its construction has been hastened on account of the very muddy condition of the Madrid water-supply, especially in the spring, and it is supposed that this reservoir will act also as a settling basin. On account of the independence of the various divisions, however, it should be easy to keep it clean.

THE AMERICAN PRESS

Review of Leading Articles

Theatre-Sanitation.

THE subject of the sanitary arrangements of public buildings, always an important one, is especially so when it relates to theatres and other auditorium structures. For this reason much interest is attached to a paper upon the subject of theatre-sanitation, read before the American Public Health Association by Mr. Wm. Paul Gerhard, and published in *Sanitarian*.

Mr. Gerhard calls attention to the fact that the sanitation of places of amusement has been much neglected, mainly, no doubt, because the stay in such buildings is generally brief; but the large number of people frequently assembled in them renders the problems of warming, ventilation, and general sanitation peculiar in nature and treatment.

Under the peculiar conditions of theatre-construction there are few, if any, windows to the outer air which can be used for flushing, and, if no satisfactory ventilating system is installed, the audience is compelled to breathe, for several hours in succession, a noxious combination of the products of combustion due to gas illumination and of the respiration and perspiration of hundreds of people, some of them doubtless in need of a thorough washing, while many are clothed in ill smelling and dirty underclothes.

There is small wonder that chemical analysis has shown the air in a theatre at the close of a performance to be more foul than the air of street sewers. Even when ventilating flues are included in the original construction of the building, or are added afterward, the incoming air is often drawn over filthy surfaces, and may be foully contaminated before it enters the building.

The dust problem is an important one in all theatres, since the dust on the stage is usually well stirred up by the scene-shifters between the acts, and floats out into the auditorium every time the curtain is raised, while the predominance of plush upholstering and heavy draperies adds to the difficulty of dislodging the settlings which accumulate.

Some of the worst abuses in that portion of the theatre behind the scenes arise from the use of old-fashioned buildings for modern spectacular performances, thus crowding the accommodations far beyond the original provision. This is especially true of dressing-room and toilet-room accommodations, to which, in all new structures, especial attention should be devoted.

Mr. Gerhard divides the subject into the departments of drainage, plumbing, water-supply, ventilation, lighting, and general sanitation. In regard to drainage, the principal problem, apart from the provision of ample capacity, lies in the fact that the so-called "under stage" is frequently below the sewer level, so that provision for pumping of drainage and for the prevention of entrance of sub-soil water must be made.

The plumbing of theatres should receive at least the same care given to that of other public buildings, while, as a matter of fact, it is usually badly done and worse cared for. Automatic flushing devices should always be used, as the public is generally very careless in handling the usual forms of apparatus. The main point emphasized is the provision of ample toilet accommodations, with plenty of water and air, using plain fittings of good quality, with every opportunity for access.

In regard to water-supply, two distinct systems are recommended, the fire protection being entirely separated from that for the plumbing system, and the arrangements otherwise not differing greatly from those of other public buildings.

The important subject of ventilation is discussed by Mr. Gerhard at length, and the question of keeping an auditorium comfortably warm, while changing the entire volume of air three or four times

an hour is shown to be feasible as well as necessary.

The introduction of incandescent electric lighting marked the beginning of a new era in theatre-sanitation. Much of the vitiation of the air formerly came from the innumerable gas flames, both on the stage and in the audience; with the removal of this source of contamination the problem of ventilation has been immensely simplified. The fire risk has also been greatly reduced, so that three of the important features in theatre-sanitation have been most favorably affected by the advance made in lighting.

Speaking generally of the improvements which might be made in theatre-sanitation, Mr. Gerhard suggests more simple and thorough methods of cleaning the auditorium, including provision for scrubbing and sweeping every part. Leather-covered chairs are to be preferred to plush upholstery, while curtains and draperies are objectionable both because of the lodgment which they afford for dust and the assistance which they give to the spread of fire. There is really nothing about the whole subject which will not readily commend itself to the owner, manager, performer, or auditor, and the additional expense incurred by the introduction of proper sanitary appliances and care should readily be met by the increased popularity of the house in which it is known that such precautions have been taken.

The Question of Depreciation.

ONE of the most important points with which the modern industrial manager has to contend is the rate at which his plant depreciates. Formerly the terms "depreciation" and "wear and tear" were practically synonymous, but at the present time this is by no means the case. Many a machine which is actually good for many years of excellent service must be thrown out of service long before it is really worn out, simply because the owner recognizes that he cannot afford longer to use it in competition with rivals equipped with more modern machinery of far higher efficiency. This fact is now well recognized by manufacturers, in the United States at least, but seems even yet to be most unwillingly accepted by other lines of industry. Thus, in a paper on "The Coming Electric Railway," by S. H. Short, in *The Cosmopolitan*, the following passage occurs:

"Conservative railway men say that an insuperable obstacle in the way of substituting electricity for steam on the trunk line systems of the United States is the enormous sum—thousands of millions of money—now invested in steam railroad plants, which, it is assumed, would be rendered practically useless by such a change of motive power. There are thirty thousand steam locomotives, they say, in service today on American railroads. Putting their average cost at ten thousand dollars each, these steam locomotives represent three hundred million dollars of capital. It is impossible to conceive of the sale of three hundred millions worth of machinery as scrap iron."

Accepting this curious statement as the opinion of railway men, it goes to prove only that they have indeed been "conservative" in that they have neglected the signs of the times to a far greater extent than have the managers of other industrial enterprises. In the first place, the idea of considering the cost value of so rapidly depreciating machines as locomotives as a portion of capital is contrary to the truth; it is really only a question of time when any such asset as operative machinery must be sunk altogether, and this is a question which must be faced and solved, not dodged and evaded.

As a matter of fact, the problem is by no means new; on the contrary, it is very old. The introduction of "villainous saltpetre" into mediæval warfare, and the development of fire artillery, certainly rendered worthless untold values in the form of fortifications, armor, and weapons; the stage-coach superseded the post system, as the railway itself did the stage-coach. The horse-car has vanished before the electric trolley, and no feeble wail of depreciated values availed to suppress the clang of the motorman's gong. This idea of offering the loss of existing locomotives

as a reason for the retention of steam locomotion reminds one forcibly of the opposition to the abolition of the court of chancery on the ground that to do so would deprive a large number of most estimable practitioners of a means of livelihood, and is so ludicrous as to make one wonder whether it is really offered seriously.

No one who considers the subject for a moment can deny that, should one of the great trunk lines equip its road with electricity, and thus, to use Mr. Short's own words, "reduce the time between New York and Chicago to ten hours and readjust the conditions of business and social life to a standard of one hundred and twenty-five miles an hour instead of forty," the competing railways would be compelled to scrap so much of their capital as is represented by steam locomotives. No considerations of cost could prevent such action; it would merely be a question of existence.

Such being the case, and with so clear and obvious a warning as the past few years have presented, is it not important that a far more rapid rate of depreciation of all machinery liable to sudden replacement should be assumed?

The old idea that a machine with an apparent life, for example, of ten years, was properly depreciated by charging off one-tenth of its purchase price every year must to-day be replaced by a constant watchfulness of possible improvements in the line of work to which each machine belongs, and a prompt and rapid concentration of work upon any tool which may soon be superseded, with a view of making it earn the price of its inevitable replacement.

In this connection we may quote some emphatic statements from *Engineering*, which, although they have already been given in these columns, will bear repeating and emphasizing, especially in view of the revival of the idea that imaginary capital in the form of rapidly-depreciating machinery can be an obstacle to the march of improvement.

"Business is like a race; the entrance-money is only returned in the form of prizes. The man who drops out gets nothing back. Once a man has embarked his fortune in manufacturing, he can only regain it by being successful. He must constantly find more and more capital, and spend increasing sums on machinery; every year this necessity becomes more urgent."

"The machine that does not earn a profit is merely a useless encumbrance, however satisfactory it may be to look at, and it is actual economy to break it up with a sledge-hammer rather than to keep it filling up valuable space. This is a condition to which every machine comes in time,—often in a short time,—and, unless the owner has accumulated money to replace it by a better and a more expensive one, he has been living on his capital, whilst deluding himself with the idea that he was only spending his profits."

That this view of the case has not been taken by railroad men may be due to their "conservatism," but a better term for such *in*-action is recklessness.

Permanent Way for Railways.

IT has developed, with advancing civilization, that permanent construction of works is the best safeguard against waste. In no department of construction is this fact more evident than in the building of road-bed and track for railways, for the destructive action of natural forces and of heavy passing loads requires an almost constant adjustment and repair to maintain these structures in operative order. It is hardly fair to call the American railway track of to-day a permanent way, because of the perishable nature of the wooden cross-ties and the weakness of spikes, etc., and also because of the upheavals and settlings due to the actions of frost and heavy loads.

In *Engineering News* Mr. J. W. Schaub has presented for consideration a system of track construction designed to render the "permanent way" of a railway really permanent. It consists, in effect, of a continuous reënforced concrete structure resting on a bed of Telford, and carrying lines of heavy rails tied together by long bolts passing through the upper part of the mass of concrete. This is brought up between the rails until its crowned top is

flush with their upper surfaces. The whole structure will shed water away from its foundations, and will naturally result in an extremely rigid and permanent track. It will as certainly result in a very costly track, the author giving figures of cost at about $14,000 per mile without the rails; but, as the maintenance cost will be equally reduced and certain other expenses of operation lessened, an annual saving of nearly 4 per cent. on the cost of the reconstruction is also calculated.

In the editorial comment accompanying this article there is an extended discussion of the necessity for betterment of railway track systems from the standpoint of permanence and operative economy. The time has come when the two really large items of track maintenance are labor and tie-renewals. With the rapid diminution of forest areas the price of ties has steadily increased, and it cannot be very long before the conditions will necessitate either metallic ties or a return to the longitudinal support system. All recent experience with street railways, where the conditions of service are even heavier than on steam railways, has demonstrated that this method of construction possesses great advantages. At the best the cross-tie system was a make-shift; its retention today is a concession to conservatism.

In the American climate, with its severe winters, frost is the greatest enemy to alignment. No system which does not eliminate this difficulty can truly be called permanent. In the system described above the under parts of the structure are protected from water, and hence from the destructive action of frost, by the use of a very large mass of concrete. In an alternative system, proposed and illustrated in the editorial comment already referred to, the construction follows more closely that whose excellence has been proven by many street-railway lines. On the levelled and rolled surface is laid down a thin layer of sand. Upon this are placed concrete beams, of trapezoidal cross-section, into which are molded holding-down bolts of one-inch iron. These concrete beams are made up in sections about ten feet long, at any point convenient to proper stone or gravel, and their ends are provided with stout iron dowels and sockets. The rails are laid upon the upper surfaces of these beams, stout gage-bars, having holes for the reception of the holding-down bolts, maintaining them in perfect gage at all times. These gage-bars pass under the rail, embracing the outer end and lower surface of the flange, and are themselves held down by the bolts. Upon these bolts are also placed stout rail clips, so that, when the nut is in place, the rail, gage-bar, and concrete beam are held firmly together and in place. The space between the concrete beams is then filled with earth, crowned over at the top, and covered with a thin layer of asphalt. At the outer sides of the concrete base-beams a similar protection is applied, the result being a perfectly solid and permanent track, impervious to moisture and free from danger of upheaval through freezing or of settling through washing.

It should not be forgotten, in connection with this discussion, that the day is not far distant when the motive power of railways will be changed from steam to electricity. The probability and even imminence of this should not be lost sight of in any design for permanent way; otherwise the same difficulties of depreciation noticed so often elsewhere may be encountered. A track built solely with a view to present speeds and methods of train-propulsion may be found useless in a few years, even if its condition is excellent, in case it is not adapted to the electric-traction methods that will then be in vogue.

Conversion of the Washington Tramway System.

THE city of Washington has lately been the scene of some very interesting work, occasioned by the change from cable to electric traction on the principal street-railway lines. The history of the electric railway in Washington is an instructive instance of the appreciation which this system of tramway traction universally meets. Two years ago one of the street-railway lines there, then operated by horses, installed an elaborate electric-con-

duit system, but built its conduit so that it could be used for a cable, in case the electric system was found unsatisfactory. The immediate and remarkable success of this undertaking led the rival street-railway company to consider the question of changing its extensive system of cable roads to electric-conduit railways. A decision to do this was greatly accelerated by a fire which entirely destroyed the large central power house of the cable system, leaving these lines without motive power. Work was begun at once on the alterations, and carried on with the utmost speed until they were completed.

In a very complete description of the whole of this installation the *Electrical World* describes the methods used in transforming the cable conduit into an electrical subway. The cables and sheaves having been removed, the large porcelain insulators, from which the conductors are suspended, were bolted in place on the lower webs of the slot rails. This work necessitated the making of three new hand-holes in each 31½ feet of the track, the cable man-holes being at that distance apart. The space between the tracks was excavated, and a 24-duct conduit laid there for the copper feeders.

It is, of course, essential in an electric conduit to keep out moisture, or, at least, to prevent any water that may enter the open slot from trickling down the walls of the conduit and over the insulators. This requires that the slot rails be provided with lips to allow such water to drip harmlessly between the two conductor rails to the bottom of the conduit. The slot rails of the cable railway not being provided with these lips, but being otherwise in good condition and bedded in a first-class asphalt pavement, it was decided to rivet, onto the under sides of their upper flanges, small angle irons. This work, like the rest of the necessary drilling, riveting, etc., was perforce done by hand, there being no convenient source of power available.

Some years of wear had dropped the joints of the track rails, though these were in fairly good condition in other respects. While the other work was in progress, all the joints were brought into line, shims put in between the rail ends to tighten the joints, short rods put through the bolt holes, and masses of iron cast around the joint. As the heating of the rail ends caused them to bend upward to some extent, it was necessary to file the joints smooth by hand after the completion of the cast-welding process.

Another cable road belonging to the same company was subsequently converted, the work being made much more difficult by the fact that this line was in continuous operation, the cable running at all times except a few hours in the later part of the night.

An interesting consequence of the success of the original electric-conduit line and the converted lines is the decision by the Columbia Railway Company, now operating the last cable line left in Washington, to convert its system into an electric-conduit railway. This is to be done, notwithstanding the fact that the cable plant is practically new and in perfect working order, since it cannot compete with the electric systems.

Railway Construction in the United States.

As compared with the five preceding years the year 1898 showed a considerable and satisfactory increase of railway mileage in the United States. In 1892 there was laid down 4,192 miles of new track, this amount being somewhat less than that constructed in 1891, but more than has been added to the track mileage of the country in any year since. In 1897 there were only 1,880 miles constructed. Last year the new mileage amounted to 3,018 miles, with much more work begun, but retarded by the exceptionally bad weather of the fall and early winter.

The *Railway Age* gives an interesting tabulated statement of these additions. It appears that the extensions were constructed by 222 lines in no less than 45 States and territories, only five States—New Hampshire, Massachusetts, Rhode Island, Kansas, and Nevada—having built no new track. The greatest increase was in Minnesota, where 250 miles of new lines were laid.

The greatest activity has been in the southern and southwestern sections of the country, where fifteen States have built nearly one-half the total new mileage. There has been little new work in the New England States. On the Pacific coast nine States have built 430 miles, and the middle northern States have added to the total only 532 miles.

In addition to the above, there are several hundred miles of road on which track-laying is in progress, or is just beginning, and many hundred miles more are graded, on which track will not be laid until next spring. The indications for the coming year point to a season of great activity in railway-building, many important lines being projected in different parts of the country.

Compound Engines.

THE question of the most advantageous ratio between the areas of the cylinders of compound engines has of late been the subject of a somewhat animated discussion, mainly because of the wide departure from accepted practice advocated by Mr. George I. Rockwood, but the very excellent performance of those engines which have been constructed from his designs has gone far to support the correctness of his views, and hence a recent paper presented by him before the Providence Association of Mechanical Engineers, and published in the *Engineering Record* is of interest at this time.

The cylinder ratio formerly was, and still is, fixed within very narrow limits in all compound engines, whether built in the United States or in Europe. Continental manufacturers have favored a proportion varying from the ratio 1:2.75 to the ratio 1:3.25. English and American builders have generally adopted a slightly larger ratio, namely, one varying from the ratio 1:3 to the ratio 1:4. A common rule is to make the diameter of the low pressure cylinder two inches less than twice the diameter of the high pressure cylinder. These proportions have been adopted with the idea that they cause the minimum amount of "drop" in pressure between the two cylinders, it having been generally assumed that such "drop" is very wasteful.

Mr. Rockwood calls attention to the fact that there are two causes of "drop," one being intermediate expansion, due to the fact that the engine is so proportioned that more steam by volume leaves the receiver than is put into it per stroke, so that the receiver pressure is bound to be less than the pressure at release in the high-pressure cylinder. The other causes of "drop" are cylinder condensation and clearance in the low-pressure cylinder.

The usual practice in steam-engine design has been to use compounding with two cylinders and a ratio of about 1:3 for pressures up to about 115 pounds, using 12 to 15 expansions, and when high pressures are possible, and greater expansion desired, three or more cylinders have been employed.

Mr. Rockwood maintains, however, that as good results can be attained with a compound engine having cylinders of the same ratio as those of the high and low pressure cylinders of a triple-expansion engine as are possible when three cylinders are employed, and acting upon this conviction he has designed several compound engines with a cylinder ratio of about 1:7. These engines have given remarkably good results, being sold under a guarantee to use not over 12½ pounds of dry steam per i. h. p., and having in most cases surpassed this performance.

"The very best performance of any mill engine which has been tested by recognized and competent experts is one of this type running at the mills of the Grosvenor Dale Company, and tested by Mr. Barrus. The steam consumption was 11.89 pounds total per i. h. p. per hour, and the coal consumption was 1.18 pounds."

Mr. Rockwood puts himself on record as saying that he believes that a pumping engine of the largest size, working with practically no clearance, with steam at a boiler pressure of 180 pounds and a cylinder ratio of 1:8, would give a horse power on a consumption of less than 11 pounds of steam and a coal consumption of one pound per i. h. p. per hour.

The analysis which has been made by

Dr. Thurston on the Sibley College experimental engine confirms Mr. Rockwood's theory in so far as to show that the "drop" which occurs between the cylinders acts to improve the quality of the steam, showing that cylinder condensation does not depend directly and solely on the range of temperature of the steam. The extent of the surface exposed and the amount of "drop" have at least as much to do with it.

Wooden Stave Pipe.

As a consequence of the proposal to construct a pipe-line of over 300 miles in length in order to conduct water from the coast to the Coolgardie mining district in Western Australia, there has been a number of suggestions as to the best kind of pipe to be used for the purpose. The varieties proposed include thus far only metal pipe, and the commission recommended the use of straight riveted steel pipe, besides suggesting some experiments with the Ferguson pipe, a form of steel plate pipe with rivetless dovetailed longitudinal joint.

In a paper read before the Technical Society of the Pacific Coast by Mr. D. C. Henny, and published in the *Journal of the Association of Engineering Societies* the advantages of wooden stave pipe for the conveyance of water under pressure are set forth, and some very interesting data and information given.

From experience obtained on the Pacific coast and in the western United States the wooden pipe has done remarkably well in actual service. So far as losses of water from leakage and evaporation are concerned, measurements upon three wooden pipe lines have been made from which the actual losses can be determined. A test of 2½ miles of 18 inch pipe made at Astoria, Oregon, showed results which the author believes have never been surpassed by any other pipe construction of this class. The pipe was filled from the head works and the gate at the lower end of the section was closed and after the stand pipe had filled the head gate was closed.

"This gate was not absolutely tight, but permitted the passage of a little trickling stream, not exceeding one quart in a minute. The assistant engineer in charge of the works was much surprised on the following day to observe this same little trickling stream apparently undiminished in quantity, passing through the waste pipe at the end of the line."

Another test of 4.3 miles of 14 inch pipe near Los Angeles, in which the flow was carefully measured by weirs and gauges at both ends. As the measurements at both ends showed practically the same results, no leakage whatever was detected. The pressure in the Astoria pipe ranged from 0 to 80 feet, the thickness of the Douglas fir staves being 1⅜ inches, while in the case of the pipe at Los Angeles the pressure varied from 0 to 65 feet, and the thickness of the redwood staves was 1⅜ inches.

A very remarkable case is given of a 52 inch wooden stave pipe 968 feet in length in the form of an inverted siphon, built to carry the water of the Santa Ana Canal across Deep Canyon near Redlands, California. The lower portion of this pipe is subjected to a pressure of 165 feet, and the pipe was laid upon the surface of the ground the lower portion being carried across the stream at the bottom by means of a trestle. When filled with water and standing full the total loss of water was about 600 gallons per day, corresponding to about 0.057 gallons per square foot of exterior surface per day.

The limiting pressure which it is considered advisable to use with pipe of this sort is about 200 feet head, and experience has shown that in the case of redwood and Douglas fir there will be no loss from percolation when the pipe is buried, even at the highest pressure. As about 80 per cent. of the Coolgardie line requires a pressure of 200 feet, or less, there appears to be no objection to the stave pipe on the score of insufficient strength.

The question of the life of the pipe depends upon the exposure. When the pipe is laid upon the surface of the ground the exposure to the action of atmospheric changes results in a gradual external decay, causing a loosening of the bands, and when the decay reaches a depth where

there is a permanent saturation there is a material increase in the loss from evaporation. Exposed lines in New England, built of pine, have lasted from 20 to 40 years, and a longer life might be expected of sound redwood.

When the pipe is buried, however, as is generally the case, the staves will remain water-soaked for their full thickness, and no decay will occur. The steel bolts and couplings will then be unprotected and the endurance of the pipe will be measured by that of the metal. Sufficient experience has not yet been had to determine the life of the metal under these conditions. The pitting which injures steel pipe would hardly be sufficient to impair the strength of the bands, and even if the metal was not fully protected against corrosion, it seems as if the stave pipe would last quite as long as steel pipe under the same conditions.

From the limited number of experiments which have been made upon carrying capacity it appears that the lower resistance to flow in the case of wooden pipe as compared with steel is a factor worthy of consideration, being equivalent to a reduction of 16 per cent. in head in the case of the Coolgardie line. Mr. Henny gives some useful computations of the value of "n" to be used in the Kutter formula for wooden stave pipe, and the whole paper is a valuable contribution to this branch of hydraulics.

The Work of the United States Coast Survey.

As long ago as 1807 the first appropriation was made by the United States government for a survey of the coast. In 1832 the Coast Survey was made a permanent department, and in 1843 its organization was revised and put upon the present basis. The work it has done, and its value, are so little known, that the paper of Mr. John F. Hayford in *Engineering News*, upon this subject possesses more than ordinary interest.

The whole coast of the United States has been accurately surveyed and charted, and an enormous number of off shore soundings have been made and plotted. The work upon the gulf-stream, its origin and mechanism, has done much toward a final understanding of this strange current. Tidal observations extending over many years and at a very great number of stations have furnished most complete and valuable data for tidal predictions. Magnetic observations, commenced originally for data for the correction of ship's compasses in harbor, have extended into an elaborate magnetic survey of the territory of the United States, unequalled for accuracy and extent.

But perhaps the most important work of the coast survey has been the measurement of two great arcs of the earth's surface. One of these, an oblique great-circle arc, extends from Calais, Me., to Fort Morgan, Ala., a distance of 1500 statute miles. The other, an arc of the 39th parallel of latitude, extends across the country and is no less than 2600 statute miles long. One of the proposed arcs will extend from the most southerly point of Texas to the Manitoba frontier, 23 degrees,—no other geodetic arc save that surveyed north and south through India being comparable to it in length.

"In that grandest of geographic undertakings, the measurement of the earth as a whole, another method of attack is by the use of the pendulum for the measurement of gravity at various points upon the earth's surface. The activity of the Coast and Geodetic Survey along this line may be inferred from the fact that its observers have occupied over 60 home stations and 28 foreign stations.

"The importance of a geodetic survey can not be properly judged by the number of points directly established by it. It bears the same relation to other surveys covering the same territory that the Supreme Court does to lower courts. Its results are of such a high degree of accuracy that it stands in the position of a court of last resort among surveys; it serves to prevent too great an accumulation of error in other surveys; to decide as to the right when two or more determinations by different surveys disagree; and to furnish indisputable points of departure for new surveys."

THE ENGINEERING INDEX

INTRODUCTORY

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language;* and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of $1.00; G, of $1.20; and H, of $1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

Serial publications are indexed on the appearance of the first installment.

SPECIAL NOTICE.—To avoid the inconvenience of letter-writing and small remittances, especially from foreign countries, and to cheapen the cost of articles to those who order frequently, we sell coupons at the following prices:—20c. each, or twelve for $2, thirty-three for $5, and one hundred for $15.

Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents: thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

Write for a sample coupon—free to any part of the world.

CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10c. per month, or $1.00 a year; to non-subscribers, 25c. per month, or $3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, a bi-weekly, *s-w*, a semi-weekly, *m* a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

American Architect. *w.* Boston, Mass.
American Electrician. *m.* New York.
Am. Engineer and Railroad Journal. *m.* New York.
American Gas Light Journal. *w.* New York.
American Geologist. *m.* Minneapolis, Minn.
American Journal of Science. *m.* New Haven, Conn.
American Journal of Sociology. *b-m.* Chicago, Ill.
American Machinist. *w.* New York.
Am. Manufacturer and Iron World. *w.* Pittsburg, Pa.
American Shipbuilder. *w.* New York.
Am. Soc. of Irrigation Engineers. *qr.* Denver, Col.
Annals of Am. Acad. of Pol. and Soc. Sci. *b-m.* Phila.
Annales des Ponts et Chaussées. *m.* Paris.
Ann. della Societa d. Ing. e d. Arch. Ital. Rome. *b-m.*
Architect. *w.* London.
Architectural Record. *q.* New York.
Architectural Review. *s-q.* Boston, Mass.
Architecture and Building. *w.* New York.
Architektonische Rundschau. *m.* Stuttgart.
Atlantic Monthly. *m.* New York.
Australian Mining Standard. *w.* Sydney.
Automotor and Horseless Vehicle Jour. *m.* London.
Bankers' Magazine. *m.* New York.
Bankers' Magazine. *m.* London.
Bankers' Magazine of Australia. *m.* Melbourne.
Berg-und Hüttenmännische Zeitung. *w.* Berlin.
Board of Trade Journal. *m.* London.
Boston Journal of Commerce. *w.* Boston, Mass.
Bradstreet's. *w.* New York.
Brick Builder. *m.* Boston, Mass.
British Architect. *w.* London.
Builder. *w.* London.
Bulletin Am. Iron and Steel Asso. *w.* Phila., Pa.
Bulletin of Bureau of Am. Republics. *m.* Washington.
Bulletin de la Société d'Encouragement. *m.* Paris.
Bulletin of Dept. of Labor. *b-m.* Washington, D. C.
Bulletin of the Univ. of Wisconsin, Madison, Wis.
Bull. Int. Railway Congress. *m.* Brussels.
California Architect. *m.* San Francisco, Cal.
Canadian Architect. *m.* Toronto, Ont.
Canadian Electrical News. *m.* Toronto, Ont.
Canadian Engineer. *m.* Montreal, P. Q.
Canadian Mining Review. *m.* Ottawa, Ont.
Century Magazine. *m* New York.
Chautauquan. *m.* Meadville, Pa.
Chem. Met. Soc. of S. Africa. *m.* Johannesburg, S.A.R
Colliery Guardian. *w.* London.
Commerce. *w.* London.
Compressed Air. *m.* New York.
Comptes Rendus de l'Acad. des Sciences. *w.* Paris.
Consular Reports. *m.* Washington, D. C.
Contemporary Review. *m.* London.
Cosmopolitan. *m.* Irvington, New York.
Deutsche Bauzeitung. *b-w.* Berlin.
Dingler's Polytechnisches Journal. *w.* Stuttgart.
Domestic Engineering. *m.* Chicago, Ill.

Eclairage Electrique. *w.* Paris.
Electrical Engineer. *w.* London.
Electrical Engineer. *w.* New York.
Electrical Engineering. *m.* Chicago, Ill.
Electrical Review. *w.* London.
Electrical Review. *w.* New York.
Electrical World. *w.* New York.
Electrician. *w.* London.
Electricien. *w.* Paris.
Electricity. *w* London.
Electricity. *w.* New York.
Elektrochemische Rundschau. *b-m.* Frankfurt.
Elektrochemische Zeitschrift. *m.* Berlin.
Elektrotechnisches Echo. *w.* Magdeburg.
Elektrotechniker. *b-m.* Vienna.
Elektrotechnischer Anzeiger. *s-w.* Berlin.
Elektrotechnische Zeitschrift. *w.* Berlin.
Elettricita. *w.* Milan.
Engineer. *w.* London.
Engineer. *s-m.* Cleveland, O.
Engineers' Gazette. *m.* London.
Engineering. *w.* London.
Engineering Assn. of the South. Nashville, Tenn.
Engineering and Mining Journal. *w.* New York.
Engineering Journal. *s. an.* Stanford Univ., Cal.
Engineering Magazine. *m.* New York & London.
Engineering News. *w.* New York.
Engineering Record. *w.* New York.
Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
Fire and Water. *w.* New York.
Forester. *m.* Washington, D. C.
Forum. *m.* New York.
Foundry. *m.* Detroit, Mich.
Gas Engineers' Mag. *m.* Birmingham, England.
Gas World. *w.* London.
Génie Civil. *w.* Paris.
Gesundheits-Ingenieur. *s-m.* München.
Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
Glaser's Ann. f. Gewerbe & Bauwesen. *s m.* Berlin.
Gunton's Magazine. *m.* New York.
Harper's Weekly. *w.* New York.
Heating and Ventilation. *m* New York.
Ice and Refrigeration. *m.* New York.
Ill. Carpenter and Builder. *w.* London.
Illinois Soc of Engs and Surveyors. Peoria, Ill.
India Rubber World. *m.* New York.
Indian and Eastern Engineer. *w.* Calcutta.
Indian Engineering. *w.* Calcutta.
Industries and Iron. *w.* London.
Inland Architect. *m.* Chicago, Ill.
Iron Age. *w.* New York.
Iron and Coal Trades Review. *w.* London.
Iron & Steel Trades' Journal. *w.* London.
Iron Trade Review. *w.* Cleveland.
Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
Journal Assn. Eng. Societies. *m.* Phila., Pa.
Journal of Electricity. *m.* San Francisco, Cal.
Journal Franklin Institute. *m.* Phila., Pa.
Journal of Gas Lighting. *w.* London.
Jour N. E. Waterw. Assoc. *qr.* New London, Conn.
Journal Political Economy. *qr.* Chicago, Ill.
Journal Royal Inst. of Brit. Arch. *s-qr.* London.
Journal of Sanitary Institute. *qr.* London.
Journal of the Society of Arts. *w.* London.
Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
Journal Western Soc of Eng. *b-m.* Chicago, Ill.
Kansas University Quarterly. *qr.* Lawrence, Kans.
Locomotive. *m.* Hartford, Conn.
Locomotive Engineering. *m.* New York.
Locomotive Firemen's Mag. *m.* Peoria, Ill.
Machinery. *m.* London.
Machinery. *m.* New York.
Manufacturer's Record. *w.* Baltimore, Md.
Marine Engineer. *m.* London.
Marine Engineering. *m.* New York.
Marine Review. *w.* Cleveland, O.
Master Steam Fitter. *m.* Chicago, Ill.
Mechanical World. *w.* London.
McClure's Magazine. *m.* New York.
Metal Worker. *w.* New York.
Mines and Minerals. *m.* Scranton, Pa.
Mining and Sci. Press. *w.* San Francisco, Cal.
Mining Journal. *w.* London.
Mining Reporter. *w.* Denver, Col.
Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
Mittheilungen des Vereines für die Förderung des Local- und Strassenbahnwesens. *m.* Vienna.
Monatsschrift des Württ. Vereines für Baukunde, 10 parts yearly. Stuttgart.
Moniteur des Architectes. *m.* Paris.
Moniteur Industriel. *w.* Paris.
Municipal Affairs. *qr.* New York.
Municipal Engineering. *m.* Indianapolis, Ind.
National Builder. *m.* Chicago, Ill.
Nature. *w.* London.
Nature. *w.* Paris.
New Zealand Mines Record. *m.* Wellington, N. Z.
Nineteenth Century. *m.* London.
North American Review. *m.* New York.
Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
Oest. Zeitschr. f. Berg- & Hüttenwesen. *w.* Vienna.
Physical Review. *b-m.* New York.
Plumber and Decorator. *m.* London.
Popular Science Monthly. *m.* New York.
Power. *m.* New York.
Practical Engineer. *w.* London.
Pro. Am. Soc. Civil Engineers. *m.* New York.
Proceedings Engineer's Club. *qr.* Phila., Pa.
Proceedings of Central Railway Club.
Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
Progressive Age. *s-m.* New York.
Railroad Car Journal. *m.* New York.
Railroad Gazette. *w.* New York.
Railway Age. *w.* Chicago, Ill.
Railway Magazine. *m.* New York.
Railway Master Mechanic. *m.* Chicago, Ill.
Railway & Engineering Review. *w.* Chicago, Ill.
Railway World. *m.* London.
Review of Reviews. *m.* New York.
Revista de Obras Publicas. *w.* Madrid.
Revue de Mécanique. *m.* Paris.
Revue Gen. des Chemins de Fer. *m.* Paris.
Revue Technique. *b-m.* Paris.
Revue Universelle des Mines, *m.* Liége.
Rivista Marittima. *m.* Rome.
Sanitarian. *m.* Brooklyn, N. Y.
Sanitary Plumber. *s-m.* New York.
Sanitary Record. *m.* London.
School of Mines Quarterly. New York.
Schweizerische Bauzeitung. *w.* Zürich.
Science. *w.* Lancaster, Pa.
Scientific American. *w.* New York.
Scientific Am. Supplement. *w.* New York.
Scribner's Magazine. *m.* New York.
Seaboard. *w.* New York.
Sibley Journal of Eng. *m.* Ithaca, N. Y.
Southern Architect. *m.* Atlanta, Ga.
Stahl und Eisen. *s-m.* Düsseldorf.
State's Duty. *m.* St Louis, Mo.
Steamship. *m.* Leith, Scotland.
Stevens' Indicator. *qr.* Hoboken, N. J.
Stone. *m.* Chicago, Ill.
Street Railway Journal. *m.* New York.
Street Railway Review. *m.* Chicago, Ill.
Technology Quarterly. Boston, Mass.
Technograph. *yr.* Champaign, Ill.
Terrestrial Magnetism. *qr.* Cincinnati, O.
The House Beautiful. *m.* Chicago, Ill.
The Mechanical Engineer. *w.* Manchester
Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
Trans. Am. Ins. Electrical Eng. *m.* New York.
Trans. Am. Ins. of Mining Eng. New York.
Trans. Am. Soc. Civil Engineers. *m.* New York.
Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
Trans. Am. Soc. Mech. Engineers. New York.
Transport. *w.* London.
Western Electrician. *w.* Chicago, Ill.
Western Railway Club. Pro. Chicago, Ill.
Wiener Bauindustrie Zeitung. *w.* Vienna.
Wisconsin Engineer. *qr.* Madison, Wis.
Yale Scientific Monthly. *m.* New Haven, Conn.
Year Book of Soc. of Engs. Univ. of Minn.
Zeitschrift für Locomotivführer. *m.* Hannover.
Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING.

CONSTRUCTION AND DESIGN.

Belfast, Ireland.

The Architecture of Our Large Provincial Towns.—Belfast. Illustrations and description of the architecture, with something of the history, and general appearance. 2000 w. Builder—Nov. 19, 1898. No. 24311 A.

Brickwork.

The Bonding of Brickwork. Ernest Flagg. Discusses methods of bricklaying in the United States. Ill. 3300 w. Br Build—Dec., 1898. No. 24756 C.

Building Construction.

Column and Girder Construction in Dun Building, New York City. Illustrated description of steelwork in a 15-story building, having a unique pintle construction of Phœnix columns and a new method of horizontal quadrant girders over a corner entrance. 900 w. Eng Rec—Dec. 3, 1898. No. 24362.

Building Failure.

Failure of Building Foundation Piers. Illustrates and describes the partial failure of a new 8-story, 120×110 ft. commercial building in Brooklyn. 1100 w. Eng Rec—Dec. 17, 1898. No. 24606.

Church.

Constructing Roman Catholic Church at Quetta. Description of work with estimates of cost. Ill. 3500 w. Ind Engng—Nov. 26, 1898. No. 24787 D.

Design.

The Evolution of Structural Design. F. T. Llewellyn. Discusses especially frame design and the use of effective materials, thus overcoming the forces exerted by dead and live loads, wind pressure, &c., showing that development is due more to conditions and materials than to mechanical statics. Ill. 4000 w. Jour Assn of Engng Soc's—Nov, 1898. No. 24708 C.

Earthquake Districts.

Buildings in Earthquake Districts. On the contradictions of practice and anomalous conclusions drawn, due to the variety of shock which at different times and places may constitute an earthquake. 1200 w. Ind Engng—Nov. 26, 1898. No. 24785 D.

Flat-House.

An Example of a Modern Flat House. Illustrated description of a house with apartments renting for $18 to $20 a month. 1400 w. Eng Rec—Dec. 3, 1898. No. 24363.

Foundations.

Foundations. Frederick Baumann. Considers important points with special reference to Chicago soil. Loads, areas, settling, materials, piling, wells, &c. Ill. 4000 w. In Arch—Dec., 1898. No. 24623 D.

Important Problems in Construction. William W. Crehore. The present article is devoted to methods of building foundations. Ill. 3500 w. Br Build—Dec., 1898. No. 24753 C.

Pneumatic Caisson Foundations for a Residence. Illustrated description of the eight wooden pneumatic caissons necessary to support a house 80-ft. high on made land over an old water course; also describes a new air-lock. 3800 w. Eng Rec—Dec. 10, 1898. No. 24541.

Glass Construction.

A House of Glass. Jules Henrivaux. From the *Revue des Deux Mondes*. An account of the project to construct a house entirely of glass for the Paris exposition of 1900. 2200 w. Chau—Jan., 1899. No. 24759 C.

Grain Elevator.

Large Grain Elevator, Louisville, Ky. Illustrates and describes a 400,000-bushel steel elevator. 800 w. Eng Rec—Dec. 17, 1898. No. 24604.

Japan.

The Later Architecture of Japan. Ralph Adams Cram. An interesting illustrated account of Japanese architecture, noting the deviations and tracing the progress of changes to the present time. 4000 w. Arch Rev—Vol. V. No. VIII. No. 24668 F.

Materials.

Tradition and Material in Architecture. Alexander M'Gibbon. An abridgment, by the author, of a paper read before the Perth Archt. Assn. Calls attention to the influence of materials on architecture, also the influence of tradition, and size, and gives a brief forecast of the future, based on the experiences of the past. 4000 w. Builder—Nov. 19, 1898. No. 24312 A.

Oxford.

The Buildings at Oxford from an Engineer's Point of View. J. W. Parry. A very interesting description of some of the ancient buildings at Oxford, giving many details of construction and showing numerous engineering expedients resorted to by their builders before the day of steam or jacks. Among the buildings considered are Christ Church, the Cathedral, Pembroke College, S. Martin's Church Carfax, Lincoln, Exeter, Jesus, S. John's Colleges, S. Mary Magdalen, S. Michael's Church, Balliol, Trinity and Wadham Colleges, and many others. The structural details of the Radcliffe Library are especially interesting. 4400 w. Engineering Magazine—Jan., 1899 No. 24895 B.

School Building.

The New Commercial High School at Paris. (La Nouvelle Ecole Supérieure de Commerce à Paris.) Description, with illustrations and plans, of this building, intended to accommodate 300 students. 2000 w. Le Génie Civil—Dec. 10, 1898. No. 24866 D.

Spanish Architecture.

Modern Spanish Architecture in California. Caroline L. Overman. Illustrates some beautiful types found in Southern California, and comments on the climatic conditions which render this style especially appropriate. 800 w. House Beautiful—Dec., 1898. No. 24373.

Storage.

Cold Storage Rooms. W. H. Wakeman. Describes proper construction and insulation, with some reference to piping. Ill. 2000 w. Ice & Refrig—Dec., 1898. No. 24392 C.

Street Architecture.

London Street Studies. T. Raffles Davison. Illustrates and describes some of the best efforts, with critical comments. 2000 w. Brit Arch—Dec. 16, 1898. No 24791 A.

Suburban Residence.

Suburban Residence Built of Brick. Walter Cope. Illustrates and describes a house built at a cost of $10,000, arranged with special reference to convenience. 2000 w. Br Build—Dec., 1898. No. 24752 C.

Tall Buildings.

The Tallest of the Modern Office Buildings. Illustrated description of the Park Row Building, New York, with comments on the changes in the lower part of the city, and comparison with the Great Pyramid in height and bulk. 2500 w. Sci Am—Dec. 24, 1898. No. 24702.

Theatres.

Modern Opera Houses and Theatres. Edwin O. Sachs. Review of the third volume of Mr. Sachs' work on theatrical construction and stage equipment. It treats of the planning of various parts, the provision for service, the construction, lighting, warming, ventilation, water-supply, telegraphy, &c. Ill. 2000 w. Arch, Lond—Nov. 25, 1898. No. 24452 A.

Town Hall.

Victoria Town Hall and Theatre, Singapore. Perspective view with brief description. 500 w. Ind Engng—Nov. 12, 1898. No. 24635 D.

University Building.

The Mining and Chemistry Building of M'Gill University. Describes a very complete building recently opened and dedicated. 1500 w. Eng & Min Jour—Dec. 24, 1898. No. 24772.

HEATING AND VENTILATION.

Combined Heating.

Hot Water and Hot Air Heating Combined. From a pamphlet issued by Isaac A. Shepard & Co., Phila., called "Hints About Heating." Calls attention to things to be considered, and ways of overcoming difficulties. 2000 w. Met Work—Dec. 24, 1898. Serial. 1st part. No. 24705.

Eaves.

Melting Ice from Eaves of Flat Roofs. Considers different methods that have been tried and the degree of success attained. 600 w. Heat & Ven—Dec. 15, 1898. No. 24914.

Fan System.

Fan System of Heating and Ventilating the Central Telephone Building, Paris, France. Brief illustrated description of the apparatus and novel features, with an account of an unusual method of procuring fuel and attendance. 1000 w. Heat & Ven—Dec. 15, 1898. No. 24912.

Munich.

The Heating and Ventilating of the New Court House at Munich. (Die Heizung und Lüftung im Neuen Justiz-Gebäude in München.) A general description of this important work, presented before the Munich convention of the Society of Heating and Ventilating Engineers. 3500 w. Gesundheits Ingenieur—Nov. 15, 1898. No. 24817 B.

Natural Ventilation.

Natural Ventilation. (Ventilazione Naturale degli Ambienti.) D. Spataro. An exposition of Recknagel's theory and a discussion of the most suitable types of walls for dwelling houses. Illustrated. 5000 w. Annali d Soc d Ing e d Archit Ital—Sept.-Oct., 1898. No. 24874 E.

Residence.

Heating and Plumbing a House. Describes the heating system and plumbing system of the residence of A. C. Coburn, at New Britain, Conn., giving plans. 2000 w. Met Work—Dec. 10, 1898. No. 24502.

Hot-Water Heating of a Residence. Illustrated description of a heating system with new features in the connections. 400 w. Eng Rec—Dec. 17, 1898. No. 24607.

Schools.

System of School-House Ventilation at Lynn, Mass. Illustrated description of improvements at the Centre Street School. It is a system of jacketed stoves. 1000 w. Heat & Ven—Dec. 15, 1898. No. 24915.

The Heating and Ventilating of the Schoolhouse at Neuhausen by Use of Gas. (Gasofenheizungs und Luftungsanlage im Schulhause zu Neuhausen.) A paper before the Munich convention of Heating and Ventilating Engineers. Fuel gas, generated from coke, is used. 5000 w. Gesundheits Ingenieur—Nov. 30, 1898. No. 24818 B.

Ventilation and Heating of a New Brunswick School. Describes and illustrates a small school ventilated and heated on the indirect blower system, with double ducts and air mixing at the base of the flues. 900 w. Eng Rec—Dec. 10, 1898. No. 24542.

Temperature.

The Fall of Temperature of Warm Air in Metal Ducts. J. H. Kinealy. Discusses how the fall of temperature of air passing through a duct, under stated conditions, may be determined. 1500 w. Heat & Ven—Dec. 15, 1898. No. 24913.

PLUMBING AND GASFITTING.

Hospital.

Plumbing in the Long Island State Hospital. Illustrated description of the work in an asylum for 900 patients, with description of buildings. 2400 w. Eng Rec—Dec. 3, 1898. No. 24364.

Plumbing in the Long Island State Hospital. Illustrates and describes the arrangement of the kitchen and bath-house plumbing, which required special treatment because of the insane patients using it. 1100 w. Eng Rec—Dec. 24, 1898. No. 24734.

House Drains.

Ventilation of House Drains. A report by Dr. Unna, the municipal engineer of Cologne, on experiments made upon the necessity of fixing secondary ventilating pipes for house drains, and the consequent circulation of water and air in the same. Ill. 5000 w. Can Arch—Dec., 1898. No. 24691 C.

House Plumbing.

Hints on Modern House Plumbing. W. F. Taaffe. An effort to simplify the application of scientific truths to the work of the plumber. 3800 w. San Plumb—Dec. 15, 1898. Serial. 1st part. No. 24687.

Ordinance.

New Plumbing and Drainage Ordinance, Portland, Ore. A copy of the ordinance regulating the plumbing, ventilating and drainage of buildings. 3500 w. San Plumb—Dec. 15, 1898. No. 24688.

MISCELLANY.

Architecture.

The Position of Architecture Among the Fine Arts. Edwin T. Hall. Considers the definitions of architecture as given by various writers, and the relations of the fine arts to each other and to architecture. Gives interesting information concerning the development and of the correct principles of design. 10,000 w. Builder—Dec. 17, 1898. No. 24779 A.

Arts.

Arts and Crafts. H. Wilson. Read before the Architectural Assn., London. Reviews the progress from prehistoric times, noting their influence, and showing architecture to be a complex art; and traces the evolution to the present. Discussion follows. 11,000 w. Builder—Nov. 19, 1898. No. 24313 A.

Baluster Shafts.

Saxon Baluster Shafts. Drawings and description of characteristic examples. 2500 w. Builder—Dec. 3, 1898. No. 24560 A.

Building Laws.

Building By-laws and Their Administration. W. Henman. Read at meeting of the Royal Inst. of British Archts. A discussion of affairs outside of London, and the annoyances and irritations to architects in consequence of existing evils. Discussion. 2500 w. Builder—Dec. 17, 1898. No. 24778 A.

The London Building Act and the Official Supervision of Buildings. W. Weaver. Read at meeting of the Surveyors' Inst., London. Discusses the act and the manner in which it is enforced, also the desirability of adopting the system prevailing under the Public Health Act in the provincial towns of England. 6000 w. Builder—Dec. 17, 1898. No. 24780 A.

Competition.

Some Famous English Artists on Competition. J. P. P. Quotes the opinions of Ruskin, William Morris, Walter Crane and others, commenting on the views and giving the writer's opinions. 1800 w. Am Arch—Dec. 10, 1898. No. 24548.

English Cathedrals.

On the Comparative Value of Documentary and Architectural Evidence in Establishing the Chronology of the English Cathedrals. Francis Bond. The need of careful criticism of documentary evidence, and the need of comparison with the story told by the building. Also discussion. Ill. 13,500 w. Jour of Roy Inst of Brit Arch'ts—Nov. 26, 1898. No. 24696 B.

Fire Exposure.

The Exposure Fire in the Home Life Insurance Building, New York City. Describes the fireproof construction and the conditions existing, the progress of the fire, the damage, and the facts ascertained. 1800 w. Eng News—Dec. 8, 1898. No. 24501.

Fire Protection.

A Seventeen-Story Building Tested by Fire. T. Cusack. Observations on the lessons learned by the fire effect on the Home Life Insurance Building, New York. 1100 w. Br Build—Dec., 1898. No. 24754 C.

Radical Changes Necessary in Fire Extinction in New York City. Jean Wetmore. A discussion of the inadequateness of the present fire system to protect the high buildings, with suggestions for improvements. 2500 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24671.

Report on Home Life Building Fire, New York, Dec. 4, 1898. Charles J. Everett, Jr. Illustrates and describes the building and the damage, drawing conclusions from the facts stated. 2300 w. Br Build—Dec., 1898. No. 24755 C.

The Home Insurance Building Fire. Illustrated description of the effect of a violent exterior fire, and fires on several stories, on the structure of a 260-ft. office building, the examination being made before the fire was entirely extinguished. 3400 w. Eng Rec—Dec. 10, 1898. No. 24538.

The Need of Improved Methods for Extinguishing Fire in High Buildings. Editorial discussion of this subject in connection with the partial burning of the 16-story Home Life Insurance Building in New York. 2500 w. Eng News—Dec. 22, 1898. No. 24679.

The Protection of High Buildings. Views of prominent architects, firemen, and others on the best means of protecting from fire. 2000 w. Fire & Water—Dec. 17, 1898. No. 24653.

The Status of the Fireproof Building. Oscar Lowinson. Discusses questions of fireproof protection in connection with the destructive effects of the recent fire in the Home Life Building of New York. 1500 w. Arch & Build—Dec. 24, 1898. Serial. 1st part. No. 24707.

Marble.

Marble Work. George H. Blagrove. The uses of marble in its relation to architecture are briefly discussed. 3000 w. Can Arch—Dec., 1898. No. 24690 C.

Metal-Work.

Metal-Work. T. Swaffield Brown. Read before the Sheffield Soc. of Archts. A discussion

of the principles and processes of metal-work. Ill. 6400 w. Jour Roy Inst of Brit Archts—Nov. 26, 1898. No. 24697 B.

Moving Buildings.

Moving a Five Story Brick Block. Illustrated description of the moving of a 5-story 100×65 ft. brick block, weighing 3,000 tons, a distance of 110 ft. 1100 w. Eng Rec—Dec. 17, 1898. No. 24605.

Newark Priory.

Newark Priory, Surrey. Gives ground plan of the remains, some sketches, and notes on its architectural features. Ill. 1500 w. Builder—Nov. 26, 1898. No. 24451 A.

Steel Framework.

The Use of Steel in Buildings. Edward Wood. Read before the Manchester, Eng., Assn. of Engs. A discussion of the advantages of steel as a material for the framework of buildings. 4000 w. Mech Wld—Dec. 2, 1898. No. 24554 A.

Venice.

Venice. Mowbray A. Green. Read before the Bristol Soc. of Archts. Descriptions of the architecture, with historical review. 7500 w. Builder—Dec. 10, 1898. No. 24725 A.

Windows.

Oriel and Bay Windows. Paul Waterhouse. Read at meeting of the Archt's. Assn., London. Considers the objects for which these windows are built, and the various treatments, successful and otherwise. 8000 w. Arch, Lond—Dec. 2, 1898. No. 24557 A.

The Making of Stained Glass Windows. Theodore Dreiser. An illustrated description of American work with comments on its excellence. 3500 w. Cos—Jan., 1899. No. 24661.

Wind Pressures.

Wind Pressures on Surfaces of Different Areas. C. Baillargé. An explanation of the difference in unit wind-pressures registered simultaneously on different areas. 800 w. Eng Rec—Dec. 3, 1898. No. 24361.

CIVIL ENGINEERING.

BRIDGES.

Alexander III.

False Works and Traveling Bridge for construction of the Alexander III. Bridge. (Notes sur la Construction du Pont Alexandre III. Exécution des Travaux Préparatoires. Pont Roulant de Montage.) This very elaborate description of the traveling bridge false-work for the steel arch of the Alexander III bridge is really an essay upon the continuous girder, and both the text and the 4 large plates of illustrations contain much valuable information. 11,000 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24884 E+F.

The Alexander III. Bridge at Paris. (Le Pont Alexandre III. sur la Seine.) E. Rouyer. An elaborately illustrated article on the construction of the abutments for this bridge, including a description of the caissons, concrete work, and superstructures. A fine plate giving a general elevation of the finished bridge accompanies the paper. 5000 w. Le Génie Civil—Nov. 19, 1898. No. 24862 D.

Arches.

Masonry Bridges Hinged at the Springings and the Key. (Ponts en Maçonnerie Articulés aux Naissances et à la Clef.) M. Bourdelles. This is an able review of the subject. Beginning with an historical introduction, it discusses triple-hinged arches as compared with those made solid at the springings, gives details of construction of vaults, arches and bridges of triple-hinging, and ends with a description of the general method of calculating the curve of pressures by M. Jean Résal. It is illustrated with many diagrams. 12,000 w. Ann des Ponts et Chausées—3e trimestre, 1898. No. 24880 E+F.

Berne.

The Kornhaus Bridge at Berne. (Die Kornhaus-Brücke zu Bern.) A very fully illustrated account of this fine new bridge across the valley of the Aar. The main arch has a span of 115 metres. 7500 w. 1 plate. Zeitschr d Ver Deutscher Ing.—Nov. 19, 1898. No. 24803 D.

The Kornhaus Bridge at Berne. (Le Pont du Kornhaus, à Berne.) Henry Martin. An elaborately illustrated detailed description of this important steel arch bridge. Two articles. 8000 w. Le Génie Civil—Nov. 26 and Dec. 3, 1898. No. 24864 each D.

Bridge Accident.

Destruction of a City Bridge by a Train. Illustrated description of the destruction of a highway bridge in St. Paul, Minn., by a train passing below it. 700 w. Eng Rec—Dec. 24, 1898. No. 24729.

Brooklyn Bridge.

The Safety of the Brooklyn Bridge. Editorial discussion of the condition of the bridge, urging such reconstruction as will secure absolute safety. 1800 w. R R Gaz—Dec. 16, 1898. No. 24594.

Caissons.

Brooklyn Caissons, New East River Bridge. Illustrated description of the design, construction and use of two wooden caissons, 63×79 ft. in plan, and 53 and 39 ft. high. 2300 w. Eng Rec—Dec. 17, 1898. Serial. 1st part. No. 24598.

Improvements in Pneumatic Caissons, Air Locks and Shafts. Illustrates and describes improvements made by John F. O'Rourke in the caisson shaft and the air lock. 1000 w. R R Gaz—Dec. 9, 1898. No. 24487.

Cantilever.

Bridge 1680 Metres Long over the Red River (China). (Pont de 1680 Mètres d'Ouverture sur le Fleuve Rouge.) M. Bricka. This cantilever bridge is to be built on the railway line between

Hanoi and the frontiers of China. It will have 19 spans, the longest of 348 feet. Description illustrated with one plate. 1600 w. Ann des Ponts et Chaussées—3e. Trimestre, 1898. No. 24886 E + F.

The New Bridge Across the Rhine at Düsseldorf. (Die Neue Rheinbrücke bei Düsseldorf.) A general description of the work, with data as to cost, and some account of the electric tramway over the bridge from Düsseldorf to Krefeld. 2000 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1898. No. 24814 D.

The New Bridge over the Rhine at Düsseldorf. (Die Neue Rheinbrücke bei Düsseldorf.) A brief account of the completion of this fine new braced arch bridge, with illustrations showing the method of erection. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Nov. 19, 1898. No. 24805 D.

Harlem Bridge.

Bridge Over the Harlem River. An illustrated description of the bridge which carries the N. Y. C. & H. R. R. R. over the Harlem River, at New York. 1500 w. Engng—Dec. 9, 1898. No. 24638 A.

Highway Bridges.

Highway Bridge Building. Albert W. Buel. A discussion of the character of highway bridges and of methods to improve this work. 4200 w. Eng Rec—Dec. 24, 1898. No. 24732.

Piers.

Masonry Pier Moved by Ice and Replaced. R. W. Leonard. From a paper read before the Canadian Soc. of Civ. Engs. Describes the replacing of an unfinished pier, moved out of position by the ice. 800 w. Can Eng—Dec., 1898. No. 24550.

St. Louis, Mo.

Franklin Bridge, Forest Park, St. Louis, Mo. Illustrated description of a 60-ft. arch of concrete and steel. 600 w. Eng Rec—Dec. 10, 1898. No. 24539.

Stresses.

Moving Load Stresses in Bridge Structures. Points out the necessity of experiments on the deformation of bridges under live loads for further advance in the application of the theory of fatigue in metals to practical design. 900 w. Eng Rec—Dec. 3, 1898. No. 24357.

Suspension Bridges.

New York and Brooklyn Bridge. Report of C. C. Martin, chief engineer and superintendent, on matters connected with the bridge. Considers the bridge as safe as it ever was. 1200 w. R R Gaz—Dec. 9, 1898 No. 24486.

New York and Brooklyn Bridge. W. Hildenbrand. A letter commenting on the reports made concerning the strength of the bridge, and suggesting a means of so strengthening it as nearly to double its capacity. 1000 w. R R Gaz—Dec. 9, 1898. No. 24484.

Testing.

On the Uselessness of the Testing of Iron Bridges by the Method of Loads. From the *Organ für die Fortschritte des Eisenbahnwesens.* Shows the tests to be defective and not a warranty of safety. 900 w. Ind Engng—Nov. 26, 1898. No. 24786 D.

CANALS, RIVERS AND HARBORS.

Barry Dock.

New Works at Barry Dock. An account of a visit of members of the British Assn., to these docks, with information from the paper of R. C. H. Davison, presented at the recent meeting at Bristol. Ill. 1800 w. Engr, Lond—Dec. 2, 1898. Serial. 1st part. No. 24530 A.

Canal Traction.

Electrical Canal Traction. The first of a series of articles aiming to present a résumé of the salient points given in the *Bulletin of the Assn. of Elec. Engs. of Liege* for May, 1898. The writer of the original paper was Mr. Van der Wallen. 2500 w. Elec Rev, Lond—Dec. 9, 1898. Serial. 1st part. No. 24632 A.

Chicago Canal.

The Progress of the Chicago Main Drainage Channel. An abstract of the report of William Boldenweck, President of the Board, outlining the litigation and decision which has caused so much delay of the work. 2500 w. Eng News—Dec. 15, 1898. No. 24589.

Dam.

A Great California Dam. Enos Brown. Illustrates and describes the construction of the Crystal Springs dam. 1300 w. Sci Am—Dec. 17, 1898. No. 24573.

The Castlewood Dam. A. M. Welles. Illustrated description of a dam of loose rocks faced with cement mortar masonry, built across, a torrential stream near Denver. 2400 w. Eng Rec.—Dec. 24, 1898 No. 24728.

Danube.

The Navigation of the Danube between Stenka and the Iron Gates. (Die Schiffbarkeit der Regulirten Donau-Katarakte Zwischen Stenka und dem Eisernen Thor.) Hans Arnold. An illustrated account of the operation of the canalized portion of the Danube at the Iron Gates, together with a description of the proposed utilization of the water power. 6000 w Zeitschr d Ver Deutscher Ing—Dec. 10, 1898. No. 24810 D.

Dredging.

Dredging Machine for the French Government. General view, with side elevation, and plan showing general arrangement, with description and report of trials. 1200 w. Engng—Dec. 2, 1898. No. 24525 A.

The Improvement of Tidal Channels by Pump Dredging. W. H. Wheeler. Read at the International Congress on Navigation, at Brussels. Gives examples showing that increased depth can be obtained at a reasonable cost, and that these channels, if due consideration is given to the direction of the tidal currents, will maintain themselves. 4500 w. Engr, Lond—Dec. 2, 1898. No. 24535 A.

Earth Slips.

Earth Slips on the Jordan. Level Marl Beds of the Erie Canal. George A. Morris. States

the conditions that caused the earth slips and gives illustrated description of methods adopted and the difficulties encountered. 2000 w. Eng News—Dec. 1, 1898. No. 24323.

Floods.

The High Water Catastrophes of the Year 1897. (Ueber Hochwasserverheerungen im Jahre 1897). Ferdinand Wang. A review of the floods in mountain-torrents in Austro-Hungary, with a discussion of methods of regulation and control of such streams. 2500 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1898. No. 24815 D.

Interoceanic Canals.

Interoceanic Canal Problems. Brief editorial review of the rights guaranteed the U. S. in any canal that may be built at Panama, and of matters relating to the Nicaragua canal. 1500 w. Harper's Wk—Dec. 24, 1898. No. 24682.

The Nicaragua and Panama Canals. Editorial discussion of these enterprises and their relations. 1600 w. R R Gaz—Dec. 23, 1898. No. 24719.

Lining.

Lining of the Marne-Saone Canal. (Etanchement du Canal de la Marne à la Saone). Gustave Cadart. Detailed illustrated description of methods used in lining a leaky canal in calcareous earth. The best results were obtained from thin layers of concrete made of lime and the sandy gravel of the neighborhood, though many other methods were used successfully. 14,000 w. Ann des Ponts et Chaussees—3e trimestre, 1898. No. 24881 E+F.

Massena Canal.

Methods of Work on the St. Lawrence Power Co.'s Water Power Canal Near Massena, N. Y. Illustrates and describes one of the most interesting pieces of canal work now in progress in the United States. 2800 w. Eng News—Dec. 15, 1898. No. 24588.

Nicaragua Canal.

Advantages of the Nicaragua Canal. A. S. Crowninshield. A résumé of isthmus canal projects, with a statement of the advantages, feasibility and costs, the value to the Pacific coast and Gulf states, uses in war, &c., &c. Map. 6000 w. Century Mag—Jan., 1899. No. 24799 D.

Plain Words About the Morgan Bill for Purchasing the Nicaragua Canal Concession. Editorial reviewing briefly the recent history of the enterprise and explaining the present situation, giving reasons why the Morgan bill should not be passed. 3000 w. Eng News—Dec. 15, 1898. No. 24590.

The Latest Aspects of the Nicaragua Canal Project. Corry M. Stadden. Reviews the history of the project, the propositions that have been before Congress for its construction, the opposition, and the present situation. 5000 w. N Am Rev—Dec., 1898. No. 24387 D.

The Nicaragua Canal. (Der Nicaragua Canal.) A discussion by Herr H. Claus, of the isthmian canal question from a German point of view, with reference to the papers of Messrs. Haupt and Nimmo in the Engineering Magazine. 2500 w. Glaser's Annalen—Dec. 15, 1898. No. 24822 D.

Russia.

From The Baltic to the Black Sea. The Maritime Canal from Riga to Kherson. (De la Baltique à la Mer Noire. Le Canal Maritime de Riga à Kherson.) Georges Leugny. A fully illustrated description of this important work, which is intended to make an all-Russian outlet for the Black sea. The canal will have a total length of 1600 kilometers. 6000 w. La Revue Technique—Nov. 25, 1898. No. 24857 D.

Ship Canals.

Equipment, Management and Economic Influence of the Ship Canal. W. Henry Hunter. A handsomely illustrated article, taking as its text the Manchester ship canal. It shows the enormous traffic that has resulted from the opening of this water way and the great increase in the trade of Manchester flowing from it, and states that, to-day, the canal is worth £1,000,000 annually to that city. In more general terms the author deals with the broader question of the economic influence of canals, which by stimulating competition in the carrying industry produce progress and aid development. 2800 w. Engineering Magazine—Jan., 1899. No. 24894 B.

The Lake Erie and Ohio Ship Canal. Harold Allen. Considers the general advantages of a waterway in this section, and the plans of a route recently advocated. 2400 w. Yale Sci M—Nov., 1898. No. 24421 C.

The Ship Canal of Bruges, Belgium. Abstract of description given in a pamphlet issued by the company to whom the contract was let. Ill. 900 w. Eng News—Dec. 22, 1898. No. 24680.

Suez.

Tides in the Suez Canal. (Etude du Régime de la Marée dans le Canal de Suez). M. Bourdelles. A very complete study of the conditions determining the movement of tides in narrow channels, with a new hypothesis to account for certain anomalies in the observed tidal movements in the canal. Illustrated. 4000 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24879 E+F.

Tiber.

The Works on the Tiber. (Les Travaux du Tibre.) M. Ronna. A second paper upon the improvement works on the Tiber, describing the bridges, embankments and other works executed from 1870 down to the present time. A very complete and valuable paper, fully illustrated. 30,000 w. Bulletin de la Société d'Encour—Nov., 1898. No. 24828 G.

IRRIGATION.

Ground Water.

The Flow of Ground Water. A statement of the sub-surface flow of water in the semi arid regions. 700 w. Eng Rec—Dec. 24, 1898. No. 24730.

MISCELLANY.

Beams.

The Action of Continuous Beams and Girders in Structural Work. (Ueber den Einfluss der Kontinuität der Balken und Trager im Hochbau.) A mathematical treatment giving formu-

las from which tables are computed for various arrangements of supports. Two articles. 2500 w. Deutsche Bauzeitung—Nov. 26, 30, 1898. No. 24832 each B.

The Moment of Inertia of Built-up Beams. E. A. Dixon. An explanation of a method for finding the moment of inertia. 1500 w. Am Mach—Dec. 15, 1898. No. 24622.

Cement.

Experiments upon the Strength and Elasticity of Portland Cements. (Expériences faites sur la Résistance et l'Elasticité de Ciments Portland.) M. de Joly. These experiments were carried out for the French lighthouse service to attain data for the construction for concrete towers. They were made on samples of neat cement, sand mortar, and concrete, and included tension, shearing and pounding. 8500 w. 1 plate. Ann des Ponts et Chaussées—3e. Trimestre, 1898. No. 24883 E+F.

The Effect of Frost on Portland Cement. Review of important experiments at the municipal cold-storage plant of Manchester, England. 1800 w. Eng Rec—Dec. 24, 1898. No. 24731.

Cement Kilns.

The American Rotary Kiln Process for Portland Cement. F. H. Lewis. Illustrated history of the process. 3300 w. Eng Rec—Dec. 17, 1898. No. 24597.

Engineering Profession.

The Work of the Engineer. Editorial on the influence of the professional work on the engineer's character. 1500 w. Eng Rec—Dec. 3, 1898. No. 24356.

Engineering Schemes.

Engineering Schemes in Parliament. Editorial discussion of the private bills for consideration in the British parliament. The present article considers the railway schemes. 4000 w. Engng—Nov. 25, 1898. No. 24431 A.

Engineering Schemes in Parliament. Editorial discussion of private bills before the British parliament. The present article treats of plans of the smaller railway companies, with some applications for light railways. 3000 w. Engng—Dec. 2, 1898. No. 24526 A.

Foundations.

A New Air Lock and Cylindrical Wooden Pneumatic Caisson for Foundations. Illustrates and describes the use of the caissons, with improvements designed by John F. O'Rourke, in laying the foundations of a residence for Mrs. Elliott F. Shepard, on 62d St., near Madison Ave., New York. Also notes other interesting features of the construction. 1800 w. Eng News—Dec. 8, 1898. No. 24500.

Framework.

Notes on the Computation of Some Special Forms of Framework. (Beitrag zur Berechnung einiger Besonderer Sprengwerksformen.) G. Mantel. A graphical and analytical examination of certain forms of framed structures. Three articles. 5000 w. Schweizerische Bauzeitung—Nov. 12, 19, Dec. 3, 1898. No. 24830 each B.

Geodetic Survey.

The Geographic Work of the Coast and Geodetic Survey. John F. Hayford. Describes the work carried on, and the value of the information furnished. Plate. 3700 w. Eng News—Dec. 1, 1898. No. 24326.

Highways.

Ancient and Modern Highways. Charles Livy Whittle. An interesting illustrated review of the progress in road making among various nations, and from earliest times. 6800 w. States Duty—Nov., 1898. No. 24304.

The Surfacing of Roads, from the Wearing, Hygienic and Economic Points of View. (Delle Pavimentazioni Stradali sotto l'Aspetto della Viabilità, dell'Igiene e dell'Economia.) Report to the Società degli Inginieri e degli Architetti Italiani by a committee. It contains an interesting history of road-making and data of cost and wearing qualities of asphalt, wood blocks, various kinds of stone pavements, macadam and telford roads. Serial. 1st part. 7000 w. Annali d Soc d Ing e d Archit Ital—Sept—Oct., 1898. No. 24870 E.

Tropical Service.

Medical Outfit and Instructions for an Engineer in the Tropics. Albert L. Ashmead, in the *Medical Fortnightly*. Describes an outfit which the writer prepared for his brother. 900 w. Eng News—Dec. 1, 1898. No. 24329.

ECONOMICS AND INDUSTRY.

COMMERCE AND TRADE.

Agricultural Machinery.

United States Agricultural Machinery in Mexico. Reports a very promising outlook for trade in these implements, without competition from abroad. 900 w. U.S.Cons Repts, No. 310—Dec. 28, 1898. No. 24706 D.

American Industry.

The Causes of the Development of American Industry. (Die Ursachen der Entwickelung der Industrie in Amerika.) Karl Wittgenstein. An important address before the Society of Austrian Engineers showing the great development of American industries, and attributing it to the great liberty permitted, as well as to ease of communication. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 9, 1898. No. 24813 B.

American Trade.

American Expansion and Trade. Editorial on the important changes likely to arise from the Philippines falling into the hands of the United States. 1800 w. Engng—Nov. 25, 1898. No. 24430 A.

Opportunities for American Trade in Germany. Reports the classes of goods that could find a market, and gives information relating to the German readiness to imitate American goods. 1500 w. U. S. Cons Repts—Dec., 1898. No. 24518 D.

British Trade.

Competition of the United States with England. Clippings from British publications bearing on this subject, with comment on the excellence of American manufactures, and the weakness of Americans as traders. 1500 w. U. S. Cons Repts, No. 311—Dec. 29, 1898. No. 24798 D.

Competition with British Trade. Extracts from newspapers bearing on this subject, with portions of the report recently issued by the British Board of Trade. 11,000 w. U. S. Cons Repts—Dec., 1898. No. 24515 D.

Competition with British Trade in Brazil. From the report of H. M. Consul-general at Rio de Janeiro. Deals with causes of the British trade decreasing, and suggests methods of improvement in production and distribution. 1500 w. Prac Engr—Nov. 25, 1898. No. 24448 A.

China.

The Yangtse Basin and the British Sphere. Archibald Little. Descriptive sketch of this region and its resources. 5400 w. Jour Soc of Arts—Dec. 16, 1898. No. 24788 A.

Debts.

Collection of Debts in Belgium and in British Guiana. Memorandum of the law with respect to the collection of debts by aliens. 2500 w. U. S. Cons Repts, No. 308—Dec. 24, 1898. No. 24750 D.

Footwear.

Americans Losing Ground in Rubber Footwear. Notes that the exports in this line have greatly decreased, and shows that it is a field where Americans ought to lead. 1500 w. Ind Rub Wld—Dec. 1, 1898. No. 24342 D.

Foreign Trade.

Foreign Trade Policies. Reports in response to a request for information in regard to the policies adopted by the respective governments to extend foreign commerce. 23,000 w. U. S. Cons Repts, No. 307—Dec. 24, 1898. No. 24751 D.

Iron Exports.

Twenty-five Years of Iron and Steel Exports to Our Colonies. Deals with the exports of the United Kingdom to various parts of the Empire of hardware and cutlery, iron (wrought and unwrought), machinery and millwork. 2800 w. Col Guard—Nov. 25, 1898. No. 24428 A.

Japanese Trade.

Trade and Industry of Hiogo and Osaka. Notes items in the last Consular report for this district, which seems destined to become the most important in Japan from an industrial point of view, and the relations to the total trade of the country. 1800 w. Engng—Dec. 23, 1898. No. 25060 A.

Machinery.

Machinery for Cuba. Raphael S. Payne. Some points on the revival of industries and trade and the needs that will soon become pressing. 1700 w. Mfrs Rec—Dec. 16, 1898. No. 24585.

Machine Tools.

English and American Machine Tools. Editorial on the work done by American automatic machine tools, and the serious nature of American competition in this line. 1300 w. Engr, Lond—Dec. 2, 1898. No. 24617 A.

Manila.

Manila a Commercial Center of the East. On the value of Manila in a commercial way, with information of the effect already noticed in eastern trade in American products. 1000 w. Bradstreet's—Dec. 17, 1898. No. 24612.

Patent Laws.

Patent Laws and the Trading Community. Editorial discussion of a debate at the Article Club, London, especially considering the views of Mr. Fletcher Moulton 4000 w. Engng—Dec. 16, 1898. No. 24747 A.

Pig-Iron.

The Late "Rig" in Cleveland Pig Iron. A discussion of the iron trade of this English district. 1300 w. Col Guard—Dec. 2, 1898. No. 24524 A.

Trade Following Pig Iron. William C. Dreher. Comments on the German fear of American competition, with report of the pig iron prices and related matters. 1500 w. Mfrs Rec—Dec. 16, 1898. No. 24586.

Port of New York.

The Commerce of the Port of New York. A statement of the fluctuations in the percentage of the foreign commerce of the United States passing through the port, and a review of measures proposed to increase its facilities. 1600 w. Eng Rec—Dec. 17, 1898. No. 24595.

Rhine Valley.

Commercial Facilities of the Rhine Valley. Information respecting the transportation between Mannheim, an important commercial center in southern Germany, and the sea coast. 900 w. U. S. Cons Repts, No. 312—Dec. 30, 1898. No. 24908 D.

Rubber Goods.

Exports of American Rubber Goods, Fiscal Year, 1897-98. Detailed statements from official sources, in advance of their publication by the U. S. Government, showing that such goods go to nearly every country in the world. 1800 w. Ind Rub Wld—Jan. 1, 1899. No. 24910 D.

Rubber Yield.

Decline in the Rubber Yield of Burma. Hawthorne Hill. A statement of the conditions existing in Burma, with the conclusion that other sources must be sought for an increase of the rubber supply. 1200 w. Ind Rub Wld—Dec. 1, 1898. No. 24343 D.

Russian Iron.

Production and Sale of Iron in Russia during 1897. The country has advanced to the fifth place in iron-producing. Gives information concerning the quality, production, prices, &c. 1600 w. U. S. Cons Repts—Dec., 1898. No. 24520 D.

Shipping Rates.

British and American Shipping Rates: Hindrances to American Exports. An editorial from the *Birmingham Post*, and a letter from G. H. Brydes, on the favorable rates from New York to Australia and New Zealand granted by

the Tyler Line (British) to American merchandise, and the reasons. 3500 w. U. S. Cons Repts—Dec., 1898. No. 24516 D.

Siberia.

The Commercial Import of the Siberian Railway. (Die Wirthschaftlishe Bedeutung der Sibirischen Eisenbahn.) Dr. Mertens. A very full discussion as to the probable influence of the opening of the Siberian railway upon trade between Europe and the Far East. 6000 w. Glaser's Annalen—Dec. 15, 1898. No. 24821 D.

Trade Conditions.

Anglophobia. Edward Atkinson. Discusses briefly some of the causes that have kept English-speaking people at variance, and especially the false views of the nature of commerce. 2200 w. Harper's Wk—Dec. 24, 1898. No. 24683.

Trade Extension.

Does Trade Follow the Flag? Lord Farrar. An examination of statistics, presenting facts from the trade of the United Kingdom mainly, which show that extension of Empire is not necessarily followed by increase of trade. 10,000 w. Contemporary Rev—Dec., 1898. No. 24578 D.

U. S. Exports.

Suggestions for United States Export Trade. Discusses the elements that have retarded the development of this trade, and offer suggestions for facilitating its development. 900 w. U. S. Cons Repts—Dec., 1898. No. 24517 D.

CURRENCY AND FINANCE.

American Currency.

British Influence on American Currency Reform. W. R. Lawson. An interesting review of American currency questions as they appear to an Englishman. 6300 w. Bankers' Mag, Lond—Dec., 1898. No. 24514 D.

Interest.

Equitable Basis of Interest. Theodore B. Stark. An explanation and justification of the payment of interest on money. 3000 w. Gunton's Mag—Dec., 1898. No. 24422 C.

Paper Money.

Government Paper Money in the Light of Political Economy and of Experience. Fred O. McFarland. Read before the Bankers' Assn. of Illinois. Quotes views of leading political economists in regard to a government credit currency, reviews the experience of other nations, and the history of the issue of legal tenders in the U. S., with writer's opinions 4800 w. Bankers' Mag, N. Y.—Dec. 1898 No. 24577 D.

Puerto Rico.

The Money of Puerto Rico. William Dinwiddie. An explanation of the financial condition of the island and the difficult money problem to be solved. 3500 w. Harper's Wk—Dec. 31, 1898. No. 24797.

GOVERNMENTAL CONTROL.

Government.

The Relations of the United States to their New Dependencies. Capt. A. T. Mahan. An essay upon the best method of realizing the fruits of recent over-sea victories. Colonial systems are contrasted and the beneficence of Anglo-Saxon rule defined. Strong sea-power is urged and the most cogent arguments adduced in favor of the retention of these colonial possessions. Lessons are drawn from the success or failure of other colonial systems and the internal development of each colony by wise administration and attention to the needs of the inhabitants is insisted upon. 2300 w. Engineering Magazine—Jan., 1899. No. 24890 B.

LABOR.

Laborers.

The Scarcity of Workmen. (Ueber den Arbeitermangel.) A discussion of the causes of the scarcity of workmen in Germany, this being mainly attributed to higher wages attracting skilled workmen to other countries. 2000 w. Stahl und Eisen—Dec. 1, 1898. No. 24931 D.

New Association.

The American Railway Engineering and Maintenance of Way Association. L. C. Fritch. On the need of organizing the association; also editorial. 2500 w. Ry & Engng Rev—Dec. 17, 1898. No. 24660.

Relief Associations.

Mutual Relief and Benefit Associations in the Printing Trade. William S. Waudby. Presents an account of the mutual relief and benefit associations in the printing and allied trades. 10,000 w. Bul of the U. S. Dept of Labor—Nov., 1898. No. 24349 D.

Socialism.

A French View of Socialism and English Trade Unions. Reviews the criticism of the influence of socialism on English working people as given in a recent book by M. Demolins. 2000 w. Jour Gas Lgt—Nov. 22, 1898. No. 24454 A.

Strikes.

Board of Trade Report on Strikes. Editorial discussion of this report on strikes and lockouts in Great Britain, for 1897. 2800 w. Builder—Nov. 26, 1898. No. 24450 A.

MISCELLANY.

Canal Traffic.

The Traffic of Notable Canals. Abstract of figures and general information from a condensed summary issued by the Bureau of Statistics of the United States. 800 w. Ry & Engng Rev—Dec. 10, 1898. No. 24567.

Combines.

Electric and Railway Combines in New York. On the tendency to combine electric street railway corporations, with those supplying electricity for light and power. Especially referring to the New York company. 1000 w. Bradstreet's—Dec. 17, 1898. No. 24611.

Cuba.

Cuba from the Standpoint of a Cuban Engineer—Prospects for Business and Work. J. de T. Tejada. A statement of past and existing

conditions. 2800 w. Am Mach—Dec. 22, 1898. No. 24699.

Education.

Commercial Education. Albert Rollit. Shows England's need of commercial education, reviews what has been done by other countries, and discusses the requirements. Discussion follows. 14000 w. Jour Soc of Arts—Dec. 16, 1898. No. 24789 A.

Commercial Education in the United States. Editorial on the need of special business training for those who are to follow commercial life. 1000 w. Eng News—Dec. 8, 1898. No. 24499.

English Views of Technical Education. W. S. Aldrich. Letter to the editor. 900 w. Eng Rec—Dec. 3, 1898. No. 24359.

The Training of the Engineer. (Zur Frage der Ingenieurausbildung.) Dr. Walther Dyck. Treating especially of the value of training in physics and the natural sciences 3000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1898. No. 24801 D.

Expansion.

The Engineer and the Policy of National Expansion. Charles B. Going. An essay upon the place of the engineer in the advance of nations. It is argued that the engineer is the real pioneer in modern national expansion, that he is the moving spirit in all material advance and that to him, solely, is due the steady and rapid rise in the standard of living, the gain in security and comfort to the individual and the vast increase in production. In all directions of growth the engineer has the closest and largest interest and to him comes the first and greatest reward. 2300 w. Engineering Magazine—Jan., 1899. No. 24891 B.

Lumbering.

Machinery and Power Applications in the Lumber Industry. William Adams. This well illustrated article gives a graphic description of the methods and machinery used in the redwood forest belt of California. The trees handled are very large and the wood somewhat brittle, so great care is requisite in felling and subsequent operations. The method of loading the logs by a cableway is also described. 3500 w. Engineering Magazine—Jan., 1899. No. 24896 B.

Paris Exposition.

The Paris Exposition of 1900. Francis E. Drake. Illustrates the general plan of arrangement and location of the buildings, and describes the features of machinery and electricity. 5500 w. W Elect'n—Dec. 10, 1898. No. 24553.

Patent Law.

The German Patent Law, and the Proper Remedy of the Engineer. (Das Deutsche Patentgesetz und die Wissenschaftliche Hülfsmittel des Ingenieurs.) Prof. A. Riedler. A discussion of the scope of the German patent law, with an elaborate examination of the recent decision in connection with the Schlick system of balancing engines. 9000 w. Zeitschr d Ver Deutscher Ing—Nov. 26, 1898. No. 24806 D.

Russia.

What We Saw in Russia. A. S. A report of the industrial conditions, with review of the history of the people. 3800 w. Loc Engng—Dec., 1898. No. 24398 C.

Tin Plate.

American Tin Plate Co. An account of the organization, personnel and charter. 4400 w. Ir Trd Rev—Dec. 22, 1898. No. 24689.

ELECTRICAL ENGINEERING.

COMMUNICATION.

Batteries.

Batteries for Exchange and Toll-Line Use from the Point of Economy and Excellence of Service. S. A. Dinsmore. Discusses dry and wet batteries and their use. 2000 w. Elec Engng—Dec., 1898. No. 25716.

Cables.

Ocean Cables. A short summary of a communication from Sir Sanford Fleming, of Ottawa, on the subject of a state owned system of electric cables for the British empire, to circle the earth. 600 w. Bos Jour of Com—Dec. 24, 1898. No. 24768.

Exchanges.

Centralized Sources of Energy in Telephone Exchanges. Kempster B. Miller. Shows the great development that has taken place in this line of work. The scope of the article includes the centralization of both calling and talking batteries. Ill. 2500 w. Elec Wld—Dec. 24, 1898. Serial. 1st part. No. 24693.

The New Exchange of the House Telephone Company, Trenton, N. J. Illustrated description. 1200 w. Elec Wld—Dec. 24, 1898. No. 24692.

Intercommunication.

Electric Intercommunication in Railway Trains. W. E. Langdon. Read at meeting of the Inst. of Elec. Engs., London. Considers (1) the electrical system; (2) mode of connecting vehicles; (3) the means for claiming the attention of the officials in charge of the train. Ill. 3700 w. Elec Eng, Lond—Dec. 16, 1898. Serial. 1st part. No. 24795 A.

Light Telegraphy.

Further Researches in Telegraphing with Light and Electricity. (Weitere Versuche über die Licht-elektrische Telegraphie.) K. Zickler. An account of the later experiments with ultra-violet light, and electrical discharges. Communication has been successfully held over a space of 1.3 kilometre. 1200 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24845 B.

Printing Telegraph.

The Higgins Type-Printing Telegraph Apparatus. Illustrated detailed description of improved apparatus possessing points of novelty.

1300 w. Elect'n, Lond—Dec. 9, 1898. No. 24629 A.

Selector System.

The Drake Selector System. Thomas C. Drake. Describes this system as worked out by the writer. Ill. 3600 w. Elec Engng—Dec., 1898. No. 24715.

Space Telegraphy.

Etheric Telegraphy. W. H. Preece. An interesting review of personal experience with this form of communication, and remarks on the Marconi system. 3000 w. Engr, London—Nov. 25, 1898. No. 24434 A.

Improvements in Magnetic Space Telegraphy. Oliver Lodge. Read before the Inst. of Elec. Engs., London. Reviews briefly the three chief methods, and explains the writer's system of magnetic induction telegraphy, and the sensitive receiving instrument which may be employed with it. 4200 w. Ind & Ir—Dec. 16, 1898. Serial. 1st part. No. 24737 A.

Wireless Telegraphy. Translation of an article by M. Ducretet, explaining his theory. 1000 w. U. S. Cons Repts, No. 306—Dec. 23, 1898. No. 24706 D.

Telegraph Cars.

The Postal Telegraph Company's Caravan. Description and illustration of the cars and equipment to be used while working in desolate regions. 1200 w. Elec Eng, N. Y.—Dec. 1, 1898. No. 24308.

DISTRIBUTION.

Alternating Currents.

Notes on the Distribution of Alternating Currents. Sidney E. T. Ewing. Notes indicating the apparatus and methods in most general use, with comments. 2800 w. Elec Eng, Lond—Dec. 16, 1898. Serial. 1st part. No. 24794 A.

Rotary Converters.

Rotary Converters. (Les Machines à Courant Alternatif "Commutatrices.") Eug. Miot. Description, with illustration, of a sub-station in Paris containing rotaries of the "Alioth" type, with details of the machines. 1200 w. L'Electricien—Dec. 3, 1898. No. 24869 B.

The Converter. C. P. Steinmetz. An article discussing the peculiarities of this machine in the way of armature heating, field reaction, &c. 4500 w. Elec Wld—Dec. 17, 1898. Serial. 1st part. No. 24584.

The Theory of the Rotary Transformer. Gisbert Kapp, in the *Elektrotechnische Zeitschrift*. The first part of a serial discussing the general principles upon which the transformation of currents is based. 1100 w. Elect'n, Lond—Nov. 18, 1898. Serial. 1st part. No. 24319 A.

Subways.

Electrical Subways, Providence, R. I. Illustrated description of the construction of subways in which special attention is paid to manholes with shelves for the cables. 900 w. Eng Rec—Dec. 3, 1898. No. 24365.

Three-Wire.

Regulation of Pressure in Three Wire Systems for Continuous Currents. (Spannungsregulirung in Dreileiternetzen für Gleichstrom.) C. del Proposto. Comparing the relative economy of different methods of regulation, with diagrams showing the corresponding arrangement of connections. 2000 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24844 B.

Wiring.

Concentric Wiring. Editorial examination of arguments for and against concentric wiring. 1600 w. Elect'n, Lond—Dec. 16, 1898. No. 24793 A.

ELECTRO-CHEMISTRY.

Accumulators.

The Present Status of Accumulator Manufacture. (Der Gegenwärtige Stand der Accumulatorentechnik.) A paper by Dr. Müllendorf before the German Society of Mechanical Engineers discussing the existing condition of electrical accumulators from a practical standpoint, especially as regards resistance to the wear and tear of daily use. 4000 w. Glaser's Annalen—Dec. 15, 1898. No. 24820 D.

The Theory of the Accumulator. Summary of an article in the *Elektrotechnische Rundschau*, in which Prof. Hoppe, of Hamburg, applies the electro chemical theory to accumulators. 2200 w. Elec Rev, Lond—Nov. 18, 1898. No. 24317 A.

Batteries.

The Use of Storage Batteries at Sea. Presents some of the dangers to an electric plant at sea, and the value of the storage battery in case of the possible accident. 1400 w. Elec Rev, N. Y.—Dec. 14, 1898. No. 24565.

Some Useful Forms of Galvanic Elements. (Ueber Einige Formen der Gebräuchlichsten Galvanischen Elemente.) E. Petersen. Data of tests upon various forms of primary batteries, investigating the chemical reactions. 2000 w. Zeitschr f Electrochemie—Dec. 1, 1898. No. 24848 G.

Carborundum.

The Manufacture of Carborundum at Niagara Falls, Ont. Brief description of the process of manufacture. 1000 w. Can Engr—Dec., 1898. No. 24552.

Chlorate Works.

The St. Michel Electrolytic Chlorate Works. John B. C. Kershaw. Brief illustrated description of these interesting works in France. 1300 w. Elec Rev, Lond—Nov. 25, 1898. No. 24444 A.

Electrolytic Bleach.

Electrolytic Bleach. (La Sbianca Elettrica.) A short general summary of electrolytic methods for making bleaching agents with data of power absorbed and costs. 900 w. L'Elettricitá—Oct. 30, 1898. No. 24859.

Electrolytic Cells.

Efficiency of the Electrolytic Cell. C. F. Burgess. Discusses methods of studying the efficiency of an electrolytic process, and the utilization of the energy of the electrolytic cell. 3000 w. Elec Wld—Dec. 24, 1898. No. 24694.

Polarization and Internal Resistance of Elec-

trolytic Cells. K. E. Guthe. Describes, with a diagram, laboratory methods of studying behavior of electrolytic cells. 1200 w. Phys Rev—Nov., 1898. No. 24490 D.

Electro-Metallurgy.

A Dissertation on Electro-Metallurgy. J. Wright. Discusses briefly the mechanical separation of iron ores by the aid of magnetic devices, the separation of the precious metals by means of the electric current, and electric welding. Ill. 4500 w. Ind & East Engr—Nov., 1898. No. 24651 D.

Magnetism.

Notes on the Chemical Action of Magnetism. (Beitrag zur Chemischen Wirkung des Magnetismus.) E. Jahr. An account of numerous experiments upon the influence of magnetism upon chemical action, with plates of photographic reproductions of phenomena. 2000 w. 2 plates. Elektrochem Zeitschr—Dec., 1898. No. 24847 G.

Review.

The Progress of Electrochemistry and Electrometallurgy during the Past 25 years. (Die Fortschritte der Elektrochemie und Elektrometallurgie Während der Letzten 25 Jahre.) A general review of the development of the industrial applications of electricity to chemistry and metallurgy in the last quarter of the century. 3000 w. Elektrochem Zeitschr—Nov., 1898. No. 24846 G.

Silicon.

The Effect of Silicon on the Magnetic Permeability of Cast Iron. F. C. Caldwell. Results of tests made upon castings poured from a small cupola, the variation in silicon being obtained by the addition of silvery iron. 500 w. Elec Wld—Dec. 10, 1898. No. 24481.

Sugar.

The Purification and Bleaching of Sugar Solutions. (Reinigung und Entfarbung Zuckerhaltiger Flüssigkeiten.) Franz Peters. A comparison of methods of purification of sugar by ozone, by electricity, and by both combined; results of experiments are given. 2000 w. Zeitschr f Elektrochemie—Dec. 1, 1898. No. 24926 G.

Timber.

Electricity and the Seasoning of Timber. A brief description of an important and novel process for the rapid seasoning of timber by the aid of electricity. 700 w. Arch, Lond—Dec. 9, 1898. No. 24627 A.

Voltaic Action.

On the Relation between the Heat Evolved and the E. M. F. Generated by Voltaic Action. Desmond G. FitzGerald. Considers the question in its bearings on the theory of lead reversible batteries. 3400 w. Elec Eng, Lond—Nov. 25, 1898. No. 24440 A.

White Lead.

Some Notes on the Manufacture of White Lead. Sherard Cowper-Coles. Part first describes various stack and chamber methods and electrolytic methods. Ill. 4800 w. Ind & Ir—Dec. 16, 1898. Serial. 1st part. No. 24738 A.

ELECTRO-PHYSICS.

Cathode Rays.

The Magnetic Deflection of Reflected Cathode Rays. Ernest Merritt. Interesting experimental research described, with conclusion that Crookes' hypothesis is the most nearly correct. 5500 w. Phys Rev—Nov., 1898. No. 24493 D.

Current Generating.

Thermo-Electric and Galvanic Actions Compared. Charles J. Reed. Considers thermo-electric and galvanic actions that have been the cause of confusion, and giving illustrations for aid in determining whether a reaction is galvanic or thermo-electric. Discussion follows. Ill. 7500 w. Jour Fr Inst—Dec., 1898. No. 24466 D.

Electrical Waves.

On the Influence of the Thickness of Air-Space on Total Reflection of Electric Radiation. J. Chunder Bose. Read before the Royal Soc. Investigations of this subject, studying the influence of the angle of incidence and of the wave length in modifying the thickness of the effective air-space. 9500 w. Elect'n, Lond—Nov. 25. 1898. No. 24445 A.

The Measurement of Short Electrical Waves and their Transmission Through Water Cells. A. D Cole. Paper read before the Am. Assoc. for the Adv. of Sci. Brief account of experimental work on the index of refraction and absorption of water for waves of 5, 8 and 16 centimetres length. 3000 w. Phys Rev—Nov., 1898. No. 24494 D.

The Refraction of Electric Waves. Abstracts of two papers communicated to the Royal Society by Jagadis Chunder Bose, "On the Determination of the Indices of Refraction of Various Substances for the Electric Ray" and "On the Influence of the Thickness of Air Space on Total Reflection of Electric Radiation." Published in *Nature* Ill. 1700 w. Sci Am Sup—Dec. 3, 1898. No. 24338.

Magnetic Field.

The Rotating Magnetic Field. Henry H. Norris. The discussion is confined to the primary circuits and the magnetomotive forces and consequent magnetic induction produced therein. 2000 w. Sib Jour of Engng—Dec., 1898. No. 24663 C.

Magnetism.

Modern Investigations in Terrestrial Magnetism and Currents. (Ueber Neuere Forschungen auf dem Gebiete des Erdmagnetismus und der Erdstrome.) Dr. Weinstein. A discussion of recent observations on terrestrial magnetism in Germany, with diagrams of the horizonal elements between 1884, 1887. 2000 w. Elektrotech Zeitschr—Nov. 24, 1898. No. 24839 B.

The Modern Theory of Magnetism. (Die Moderne Theorie des Magnetismus.) Dr. H. Du Bois. A discussion by the aid of quaternions, of Hopkinson's theory, read before the Mathematical Assn. at Düsseldorf. 3000 w. Elektrotech Zeitschr—Nov. 24, 1898. No. 24838 B.

Observatory.

The Toronto Magnetic Observatory. R. F. Stupart. An account of the establishment of the magnetic observatory in Canada, the buildings used, especially the one recently built. This building was made necessary as the observations at the Toronto observatory were seriously impaired by the trolley system. The greatest care was taken in its construction. 3000 w. Ter Mag—Dec., 1898. No. 24909 E.

GENERATING STATIONS.

Armature Currents.

Distribution of Currents and Energy in Short-Circuited Armatures. (Stromvertheilung und Energieaufnahme von Kurzschlussankern.) G. Roessler. A very exhaustive discussion of the action of the electrical currents in the Dobrowolski armature, using both graphical and analytical methods. Two articles. 10,000 w. Elektrotech Zeitschr—Nov. 10, 17, 1898. No. 24834 each B.

Brooklyn.

The New Work of the Brooklyn Edison Company. Illustrates and describes the main generating station and its equipment, and the installation of a 6000-volt high-tension system. 3000 w. Elec Wld—Dec. 3, 1898. No. 24383.

Design.

The Direction of Progress in the Design of Electric Lighting Plants. Considers the separate items of the plant and the forms modern experience is giving them in England. 4500 w. Engr, Lond—Nov. 25, 1898. No. 24437 A.

Dynamo.

The Largest Dynamo in the World. S. H. Short. Illustrations and description of the 3000 kilowatt machine for Boston Elevated Ry. Co., its construction, and the weights of its various parts. 1000 w. Ry Wld—Dec. 8, 1898. No. 24901 A.

Running Shunt Dynamos in Parallel. Arnold Philip. Considerations and experiments of interest in connection with the recent breakdown at Brighton, Eng. 1600 w. Elec'n, Lond—Nov. 25, 1898. No. 24446 A.

Electrical Machinery.

Multiphase Electrical Machinery. Andrew Stewart. Abstract of a paper awarded the Gold Medal of the Glasgow and West of Scotland Technical College Scientific Society. Information regarding the leading features of the multiphase system, with special reference to the generators and motors, their efficiency and regulation. 1800 w. Elec, Lond—Nov. 25, 1898. Serial. 1st part. No. 24558 A.

Field.

The Magnetic Field of a Bipolar Generator. (Das Magnetfeld einer Zweipoligen Dynamo-Maschine.) Dr. H. Hess. The distribution of the lines of force is very well shown by reproductions of iron-filing patterns, and the difference in action between a dynamo and a motor explained. 1500 w. Elektrotech Zeitschr—Nov. 17, 1898. No. 24835 B.

Isolated Plant.

A Large Isolated Plant. Illustrates and describes the plant at the Royal Agricultural Hall, Islington. 1500 w. Elec Rev, Lond—Dec. 9, 1898. No. 24634 A.

The Electric Lighting Equipment at Knowsley Hall. Illustrates and describes the buildings, generating plant, fittings and methods of lighting. 4500 w. Elec Eng, Lond—Dec. 9, 1898. No. 24630 A.

The Lighting and Power Plant of the Chicago Public Library Building. Illustrated description of an interesting plant. 2200 w. Elec Wld—Dec. 17, 1898. No. 24583.

Italy.

Electric Light and Power Plants in Naples and Trieste. (Impianti Elettrici per Luce e Forza in Napoli e in Trieste.) Carlo Gabussi. Brief description of two important installations, one of the direct-current accumulator sub-station type and the other of the single-phase alternating current variety. 1500 w. Giorn dei Lav Pubb e delle Str Ferr—Nov. 23, 1898. No. 24852 B.

Motor Works.

The Langdon-Davies Motor Works. An illustrated description of this motor, and the works where it is constructed. 1200 w. Elect'n, Lond—Dec. 2, 1898. No. 24562 A.

Paris.

Paris Central Electric Stations. Illustrates and describes some of the most important stations, noting their interesting features. 1600 w. Engr, Lond—Nov. 25, 1898. No. 24436 A.

The Place Clichy Central Station in Paris. L. Bayly. Illustrates and describes in detail the equipment. The five-wire system of distribution is used. 1500 w. Elec Rev, N. Y.—Nov. 30, 1898. No. 24309.

Power Plant.

The Installation of a Power Plant. U. Grant Kirn. The writer aims to give such information as would enable an engineer capable of taking charge of a plant, to also erect it. Ill. 7000 w. Engr, U. S.—Dec. 1, 1898. No. 24471.

The Plant of the Colorado Electric Power Company. Ralph D. Mershon. An illustrated detailed description of a plant designed with the object of supplying power to the gold mines. 2500 w. Am Elect'n—Dec., 1898. No. 24473.

Profits.

Profits of Alternating-Current Central Stations. T. M. Meston. Urges the establishment of day circuits for power users in connection with intelligent canvassing. 1000 w. Am Gas Lgt Jour—Dec. 12, 1898. No. 24549.

Sparking.

The Causes of Sparking at the Commutators and Brushes of Continuous-Current Dynamos. (Ueber die Ursachen der Funkenbildung an Kollektor und Bürsten bei Gleichstrom-dynamos.) Emil Dick. A discussion in which formulas are derived for fields of various strengths and brushes of different materials, enabling the best dimensions to be computed for any given case. 3500 w. Elektrotech Zeitschr—Dec. 1, 1898. No. 24841 B.

Switzerland.

The Electric Plant at Arosa. (Das Elektricitätswerk Arosa.) An excellently illustrated illustrated account of the hydraulic electric plant at this popular Swiss resort. Over 300 h. p. are developed from a small mountain stream. Two articles. 2500 w. Schweizerische Bauzeitung—Dec. 3, 10, 1898. No. 24831 each B.

Transformers.

Transformers in Practice. Traces the improvements in design of transformers, giving illustrated descriptions of three types in favor in England, with general remarks of interest. 5000 w. Engr, Lond—Nov. 25, 1898. No. 24435 A.

LIGHTING.

Arc.

A Photographic Study of the Electric Arc. N. H. Brown. Experimental research upon the seat of luminosity and method of formation of the arc, illustrated with three photogravure plates. 5000 w. Phys Rev—Nov., 1898. No. 24492 D.

Lighting in Gt. Britain.

The Commercial Aspects of Electric Lighting in Great Britain. Robert Hammond. A study of the cost of production of electrical energy in the United Kingdom. The curious Parliamentary regulations governing the establishment of electric lighting plants are described at length, and a comparison made between eleven stations showing low producing costs. The paper is highly instructive and of great interest. 4000 w. Engineering Magazine—Jan., 1899. No. 24899 B.

Lighting Plant.

A Gas Engine Electric Lighting Plant for the French Chamber of Deputies. Description, with illustration of a very large gas-engine plant comprising no fewer than 4610 lamps, aside from the Chamber itself. 900 w. Elec Eng, N. Y.—Dec. 8, 1898. No. 24459.

Street Lighting.

Festoons of Incandescents on Chicago Business Streets. Illustrated account of the street illumination during the Peace Jubilee celebration, and its great success. 800 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24669.

Vienna.

The Electric Lighting Plant of the Vienna City Railway. (Elektrische Beleuchtungsanlagen der Wiener Stadtbahn.) W. Koula. With a map of the distribution, and plans and views of buildings, machinery, and switchboard. 3000 w. Elektrotech Zeitschr—Dec. 1, 1898. No. 24840 B.

MEASUREMENT.

Alternating Currents.

Graphic Method for Studying Alternating Currents. (Résumé de la Méthode Graphique pour l'Etude des Courants Alternatifs.) S. Hanappe. A very elaborate mathematical treatise. It deals with the application of graphical methods to the study of machines. Illustrated with many diagrams. Serial. 1st part. 24,000 w. Rev Univ des Mines—Nov., 1898. No. 24878 G.

Capacity.

The Computation of the Electrostatic Capacity of Overhead Conductors. (Ueber die Berechnung der Elektrostatischen Kapacität Oberirdischer Leitungen.) F. Breisig. An approximate solution, taking into account the influence of the surface of the earth, the proximity of wires, and the general working conditions. 5000 w. Elektrotech Zeitschr—Nov. 17, 1898. No. 24836 B.

Diagrams.

Graphical Representations of the Gross Output of Electric Railways. (Graphische Ermittelung der Bruttoabgaben Elektrischer Bahnen.) Wilhelm Mattersdorff. Describing a method of plotting the total work of an electric railway by use of curves; illustrated by examples from Berlin tramways. 1800 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24843 B.

High Pressures.

On an Apparatus for Measuring Very High Pressures. A. de Forest Palmer, Jr. Describes the method adopted, which gave very satisfactory results. 900 w. Am Jour of Sci—Dec., 1898. No. 24347 D.

Mathematical Theory.

Report on the State of the Mathematical Theory of Electricity and Magnetism. Arthur Gordon Webster. Reviews the principal points of the development of the theory of electricity and traces its progress. 3300 w. Science—Dec. 9, 1898. No. 24477.

Meters.

Meters and Systems of Charging for Electric Energy. William Arnot. Abstract of a paper read before the Inst. of Engs. and Shipbuilders in Scotland. Discusses the costs and methods of charging. 4800 w. Elec Eng, Lond—Dec. 2, 1898. No. 24556 A.

Phasemeter.

Dr. Th. Burger's Direct Reading Phasemeter. (Phasemètre à Lecture Directe du Dr. Th. Burger.) M. Aliamet and E. J. Brunswick. A dynamometer type phasemeter of very simple construction described and illustrated. 1000 w. L'Electricien—Nov. 26, 1898. No. 24868 B.

Photometer.

A Device for Recording Photometer Settings. Charles P. Matthews. Illustrated description of a simple and ingenious device greatly improving both the speed and accuracy of photometer work. 1200 w. Phys Rev—Nov., 1898. No. 24495 D.

Resistances.

Notes on the Practical Measurement of Low Electrical Resistances. J. Warren. Investigations as to what constitutes the difference of potential. 1000 w. Elec, Lond—Nov. 25, 1898. Serial. 1st part. No. 24559 A.

Wattmeters.

A Hot-Wire Combined Ampere-Volt Wattmeter. Michael B. Field. Describes a hot-wire instrument devised by the writer for use in testing rooms, laboratories, &c., as a handy and ac-

curate appliance for determining the conditions obtaining in any circuit, viz., the current strength, voltage, power, and power factor. 2200 w. Elec Rev, Lond—Nov. 25, 1898. Serial. 1st part. No. 24441 A.

POWER APPLICATIONS.

Cranes.

The Electric Cranes of the Southampton Harbor Board. Illustrated detailed description of the new cranes. The installation consists now of six electrically-driven travelling jib cranes. 1400 w. Engr, Lond—Dec. 2, 1898. No. 24532 A.

The New Electric Cranes at Southampton Harbor. Illustrated description of these cranes and report of their satisfactory work. 1300 w. Elect'n, Lond—Nov. 18, 1898. No. 24321 A.

Elevators.

Fatal Elevator Accident in New York. Describes an unusual accident to an electric elevator due to the falling of counterbalance weights. 1200 w. Eng Rec—Dec. 10, 1898. No. 24536.

Equipment.

Electrical Equipment of the Columbia Gas Coal Company, at West Newton, Pennsylvania. George R. Wood. Illustrated description of pumping and coal-cutting machinery. 1700 w. Mines & Min—Dec., 1898. No. 24368 C.

Mine Plant.

The Electric Plant of the "Glückauf" Mine at Sondershausen. (Der Elektrische Centralbetrieb der Gewerkschaft "Glückauf" zu Sondershausen.) A very complete account of the electric power station, distribution system, and various applications of electric power at the great potash mine at Sondershausen, Saxony. 8000 w. 4 plates. Glückauf—Dec. 3, 1898. No. 24826 B.

Motors.

Induction Motors with Variable Speeds. (Ueber Induktions Motoren mit Veränderlicher Umlaufzahl.) F. Niethammer. A discussion of methods of winding by means of which rotary field motors may be arranged to run at different speeds merely by moving a switch. 2500 w. Elektrotech Zeitschr—Nov. 10, 1898. No. 24833 B.

The Electric Motor in Shop and Mine. Clarence M. Barber. Notes points interesting to the engineer who is not an electrician, but who is interested in electrical power transmission, and on the present status of the machine, 5000 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24711 C.

Navigation.

The Electrical Navigation of Rivers. (La Navigazione Elettrica Fluviale.) T. Tommasina. An argument in favor of the navigation of rivers, in Italy, by means of accumulator boats. 900 w. L'Elettricità—Oct. 30, 1898. No. 24858.

Polyphase Motors.

Polyphase Motors with Single Phase Armature Winding. (Ueber Drehstrommotoren mit Einphasiger Ankerwickelung.) Hermann Cahen. A discussion of a paper by H. Görges, describing a motor in which a reduced number of coils are used in the armature. 2500 w. Elektrotech Zeitschr—Dec. 8, 1898. No. 24842 B.

Workshops.

Electric Power in Workshops. Alex. Siemens. Traces the progress made in generating, transmitting and utilizing the energy, and shows its suitability for driving machinery. 1500 w. Engng Mech—Nov., 1898. No. 24395 C.

TRANSMISSION.

Aluminum.

The Conductivity of Aluminum. Edwin F. Northrup. Gives recent tests made on rods manufactured by the Pittsburg Reduction Company, some of the specimens being pure aluminum and others alloyed with copper. 600 w. Elec Wld—Dec. 3, 1898 No. 24384.

Electric Transmission.

Electric Transmission at the New Works of the Linotype Company. Illustrates and describes the works at Broadheath, Eng., also the electric plant, system of transmission, &c. 6500 w. Engr, Lond—Nov. 25, 1898. No. 24438 A.

Hamilton, Can.

The Hamilton, Can., Cataract Power Co.'s Plant at De Cew Falls. George W. Bowie. Illustrated detailed description of a long distance transmission plant with many novel features. 3000 w. Elec Eng, N. Y.—Dec. 8, 1898. No. 24458.

Insulating Materials.

Dielectric Strength of Insulating Materials. Thomas Gray. Paper read before the Am. Assn. for the Advancement of Sci., containing results of measurements of various substances. 3500 w. Phys Rev—Nov., 1898. No. 24491 D.

Long Distance.

Long Distance Transmission of Electric Power. George Forbes. A paper advocating long distance transmission, and considering the methods in use, and various industries to which it is applicable. Discussion. 7500 w. Jour Soc of Arts—Nov. 25, 1898. No. 24439 A.

Long Distance Transmission of Power. C. Rice Dooley. From *The Purdue Exponent.* Calling attention to growth of water-power generating plants, citing examples. 1400 w. Elec, N. Y.—Nov. 30, 1898. No. 24307.

Mains.

High-Tension Trunk Mains. Gives the experience in trying to furnish current for the Deptford station, London, and the first use of the Ferranti Trunk Main, describing it, and giving recent experience with high-tension mains, and with insulating materials. 6300 w. Engr, Lond—Dec. 2, 1898. No. 24527 A.

Paderno.

The Water-Power Installation at Paderno. G. Semenza. Lecture given before the Milan section of the Associazione Elettrotecnica Italiana. An illustrated detailed description of an interesting power transmission scheme. 1600 w. Elect'n, Lond—Dec. 16, 1898. Serial. 1st part. No. 24792 A.

Power Transmission.

Polyphase Transmission of Power. F. Wallis. Discusses the various questions relating to long-distance transmission, and how the polyphase system compares with the direct-current and with the single-phase alternating. 4400 w. Elect'n, Lond—Dec. 9, 1898. No. 24628 A.

Transmission Plant.

The San Gabriel-Los Angeles Transmission Plant. George P. Low. Illustrated detailed description of this interesting installation and its many novel features. 17,500 w. Jour of Elec—Nov., 1898. No. 24773.

MISCELLANY.

Influence.

The Social Influence of Electric Power. Editorial discussion of the influences due to electric traction and to electric motors. 1800 w. Elect'n, Lond—Nov. 18, 1898. No. 24320 A.

Invention.

The Status of Electrical Invention. William A. Rosenbaum. It is proposed to take up the main branches, and to call attention to the inventions in each. The present article deals with the telegraph and telephone. 3000 w. Jour Fr Ins—Dec., 1898. No. 24467 D.

MARINE ENGINEERING.

Compass.

The Mariner's Compass. Ernest K. Roden. Reviews what is known of the invention; describes Sir William Thompson's compass, the best one in use at the present time, discusses variations, &c. Ill. 3000 w. Home Study—Jan., 1899. No. 24686.

Construction Rules.

Wimshurst's Rules for the Construction of Steam Vessels. Gives rules for the construction of steel vessels, with editorial. 5000 w. Engng—Dec. 16, 1898. No. 24748 A.

Fire Boat.

New and Powerful Fire Boat for the City of Chicago. Illustrates and describes the chief features of the design and construction of a vessel embodying the most modern ideas for this class. 1800 w. Marine Engng—Dec., 1898. No. 24544 C.

Launches.

Our Builders Where Naphtha Launches Grow. Describes a visit to the works of the Gas Engine and Power Co., and Charles L. Seabury & Co., at Morris Heights, N. J. Ill. 1800 w. Rudder—Dec., 1898. No. 24391 C.

Load-Line.

The Report of the Load-Line Committee. Editorial stating the circumstances which led to the appointment of the committee, and commenting on the report just presented to the Board of Trade. 2200 w. Engr, Lond—Dec. 16, 1898. No. 24742 A.

Machinery.

The Machinery of Vessels on the Great Lakes and a Synopsis of Rules Compiled by the Great Lakes Register. John N. Coffin. An outline of some of the results which have been developed in compiling the Great Lakes Register. 4800 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24709 C.

Merchant Marine.

School for Merchant Marine in Russia. Translation of the regulations for the management of an institution recently organized, which has for its object the training of young men in the theory and practice of navigation. 3000 w. U. S. Cons Repts, No. 309—Dec. 27, 1898. No. 24749 D.

Sea Power.

America's Inadequate Sea Power. Editorial on the importance of the export trade, and the necessity for increasing the ocean shipping. 1000 w. Ir Age—Dec. 1, 1898. No. 24335.

Ship Construction.

The Morbid Anatomy of Iron and Steel Ships. S. J. P. Thearle. Lecture delivered to the Glasgow Univ. Engng Soc. An examination of the diseases to which these ships are liable, and the advances being made in overcoming them. 5000 w. Engr, Lond—Dec. 9, 1898. Serial. 1st part. No. 24649 A.

Shipping.

Positive Shipping Policy. The project for the creation of an American seagoing merchant fleet recommended by the Commissioner of Navigation. 2000 w. Marine Rev—Dec. 8, 1898. No. 24508.

Ships' Magnetism.

The Magnetism of Ships. (Il Magnetismo Navale.) Prof. E. Gelcich. An elaborate study of the variations of compasses on ships and the theory of compensation. It is prefaced by an interesting and valuable historical study of the subject. Serial. 1st part. 11,000 w. Rivista Marittima—Nov., 1898. No. 24876 H.

Steamer.

The "Duke of Cornwall." Illustrates and describes this new cross Channel mail steamer, built for the Fleetwood and Belfast route. 2000 w. Engng—Dec. 16, 1898. No. 24745 A.

Steam Navigation.

Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America from 1807 to 1850. Charles H. Haswell. Read at meeting of Inst. of Naval Arch'ts, March 31, 1898. 3000 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24350 H.

Steamship Trial.

Trial of the Steel Cargo Steamship Winifred. A. D. Haughton. A full description of the vessel and report of the trials. The ship goes immediately on the New York and Porto Rico steamship route. 3300 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24353 H.

Steam Yacht.

Description of the Steam Yacht Ellide and

Her Speed Trials. Illustrates and describes the boat and machinery, giving report of trials and a discussion of results. 2500 w. Marine Engng —Dec., 1898. No. 24543 C.

Steam Yacht Hildegarde. Illustrated detailed description with history of the vessel. 2500 w. Rudder—Dec , 1898. No. 24390 C.

Steel Ships.

On Some Features of the Repairs and Construction of Iron and Steel Ships. M. W. Aisbitt. Read at meeting of the North-East Coast Inst. of Engs. and Shipbuilders, at Newcastle-on-Tyne. Notes from one long engaged in the work. Discusses stanchions, web frames, double-bottoms, &c. Ill. 2500 w. Steamship —Dec., 1898. No. 24563 A.

Subsidies.

Subsidies for Ships. Full text of the measure for the revival of the American marine. 5000 w. Marine Rev—Dec. 22, 1898. No. 24767.

MECHANICAL ENGINEERING.

AUTOMOBILISM.

American.

Motor Vehicles in the United States To-day. A general survey of this new industry, giving manufacturers and inventors work, with gasoline, electricity and steam, Ill. 23300 w. Horseless Age—Oct , 1898. No. 24472 C.

Austrian Army.

Moto Vehicles for the Austrian Army. From *Die Reichswehr*, Vienna. On the advantages and disadvantages of these vehicles for army purposes. 1000 w. Automotor Jour—Dec., 1898. No. 24760 A.

Contest at Boston.

Practical Motocycles at Charles River Park, Boston, November 9. Hugh Dolnar. Considers the two main classes of mechanically propelled vehicles, and illustrates and describes various types and the contest at the place named. 3000 w. Am Mach—Dec. 29, 1898. No. 24917.

Electric.

The Electric Moto-Vehicle. C. E. Woods. Read before the Chicago Elec. Assn. Discusses the development, the cost, utility, possibilities as an industrial feature, &c. 1800 w. Elec, N. Y.—Nov. 30, 1898. Serial. 1st part. No. 24306.

Electric Cabs.

Electric Cabs in New York. Joseph Sachs. Information concerning the plant of the Electric Vehicle Company, with illustrations and descriptions of the cabs, and of their management. 1800 w. Harper's Wk—Dec. 10, 1898. No. 24461.

England.

Views on Automobilism. Sir David Salomons. Discusses the use of motor cars in England, the things that retard the progress, the pleasure to be derived, speed, &c. 2000 w. Automotor Jour—Nov. 15, 1898. No. 24300 A.

France.

The French Automobile Industry in 1897. Lucien Périssé. Excerpt from a paper contributed to the French Soc. of Civ. Engs. Classification of vehicles, the advantages and inconveniences, and improvements desirable. 2200 w. Automotor Jour—Dec., 1898. No. 24761 A.

Future Prospects.

The Modern Moto-Vehicle and Its Future. Excerpt from a lecture delivered at Liverpool, by Prof. Hele-Shaw. Inquires into the causes of failures of making moto-vehicles a success sixty or more years ago, when they were quite largely used, and discusses their future prospects. 1400 w. Automotor Jour—Nov. 15, 1898. No. 24303 A.

Heavy Traffic.

Excerpt from the Official Report of the Judges on the Trials of Moto Vehicles for Heavy Traffic Held in Liverpool. Gives particulars of the competition, illustrated descriptions of vehicles entered, the costs of working, and conclusions. 8500 w. Automotor Jour—Nov., 1898. No. 24453 A.

Heavy Weights.

Les Poids Lourds Concours. Illustrates and describes the vehicles that took part in the heavy weight trials at Versailles, France, and reports their performance. Also editorial. 4000 w. Automotor Jour—Nov. 15, 1898. No. 24302 A.

Petroleum Supply.

The Supply of Moto-Car Spirit or Petrol. George Herbert Little. Notes that a great majority of these vehicles use products of petroleum and discusses the facilities for a proper supply and distribution of the oil known as moto-car spirit and petrol. 1800 w. Automotor Jour—Nov. 15, 1898. No. 24301 A.

Physician's Carriages.

On the Choice of a Moto-Vehicle. Considers the choice of moto-carriages for the use of medical men. 1200 w. Automotor Jour—Dec., 1898. No. 24762 A.

Progress in 1898.

The Year's Progress in Motor Road Locomotion. A lengthy review of the progress in different countries, of all classes of vehicles, and of the factories and industries connected with their manufacture. Many illustrations. 37,000 w. Ind & Ir—Nov. 25, 1898. No. 24469 A.

Progress in Germany.

Revolution in Traffic. Adolph Schulze. Translated from *Ueber Land und Meer*. On the progress of automobile carriages in Germany. 2200 w. Chau—Jan., 1899. No. 24758 C.

Steam Omnibus.

Martyn's Locomotor Car or Steam Omnibus. Illustrates and describes one of the latest forms of steam carriages for common roads. The chief points of originality are the steering gear, the compensating gear, and the boiler. 1500 w. Engr, Lond—Dec. 2, 1898. No. 24533 A.

Steam Wagons.

Steam Driven Road Wagons. Hugh Dolnar. An illustrated detailed description of William B. Mason's carriage, and an explanation of its connection with the Stanley carriage. 2500 w. Am Mach—Dec. 1, 1898. No. 24332.

Traveling Vehicles.

Automobile Traveling Vehicles. From *La Nature*. Illustrates and describes the Jeantaud automobile carriage. 800 w. Sci Am Sup—Dec. 3, 1898. No. 24337.

HYDRAULIC ENGINEERING.

Flow.

Gauging in Hungary. (Jaugeages en Hongrie.) Joseph Péch. Describes at lenghth, with many illustrations, a new method of gauging streams in use by the Hydrographic department of the Hungarian Government. 8500 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24885 E+F.

New Gaugings of the Rochester Conduit. Reviews experiments on large cast-iron and riveted plate pipe lines about 20 miles long. 1200 w. Eng Rec—Dec. 10, 1898. No. 24537.

Two Formulæ for the Permanent and Uniform Flow of Liquids. (Note sur Deux Formules Relatives à l'Ecoulement Permanent et Uniforme des Liquides.) Victor Fournié. The formulæ considered are those for cylindrical pipes and open canals, and differ somewhat from those in general use. They consider a larger number of factors and, by the suppression of the less important, become more nearly expressions of real laws of flow. 1600 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24887 E+F.

Hydraulic Governor.

The Rusch-Sendtner Hydraulic Governor. From *Revue Industrielle*. Describes a new resistance or brake governor adapted for maintaining a constant velocity in any sort of a hydraulic motor. Ill. 700 w. Sci Am Sup—Dec. 24, 1898. No. 24704.

Pumps.

Recent Improvements in Centrifugal Pumps. J. Richards. Explains and illustrates the conoidal system as used for the drainage works at New Orleans. 900 w. Eng News—Dec. 1, 1898. No. 24325.

Rams.

The Durability of Cast-Iron Rams for Hydraulic Presses. "Uni." The durability of rams and the causes of their becoming rough, with means of preventing the trouble. Ill. 1800 w. Prac Engr—Nov. 25, 1898. No. 24447 A.

Turbines.

The New 2500 Horse-Power Turbines at Niagara. S. S. Knight. Illustrates and describes a pair of Geyelin-Jonval horizontal axis turbines lately installed. 600 w. Sci Am—Dec. 10, 1898. No. 24475.

MACHINE WORKS AND FOUNDRIES.

Ball Race.

The Ball Race. Mark Barr. Discusses the accuracy of ball races. 800 w. Elec Rev, Lond—Nov. 25, 1898. No. 24442 A.

Bolts.

A Chart of Bolt Strengths. Lawford H. Fry. Gives a diagram illustrative of the great amount of engineering information that can be given by the use of charts. 1200 w. Am Mach—Dec. 8, 1898. No. 24483.

Cams.

Fixture for Grinding Profile Cutters and Laying-Off Cams. A. L. De Leeuw. Description with sketch illustrating the principle of the device. 7000 w. Am Mach—Dec. 29, 1898. No. 24919.

Castings.

Patterns and Castings as Witnesses. John M. Richardson. Calls attention of young pattern makers to marks on castings and their causes. 1600 w. Am Mach—Dec. 15, 1898. No. 24618.

Porous Castings and Occluded Gases. Max H. Wickhorst. Read at the meeting of the Western Foundrymen's Assn. Explains what occluded gas is, and the troubles caused by it, dealing with the various gases separately. 4000 w. Ir Trd Rev—Dec. 29, 1898. No. 24907.

Some Recent Experience in Casting Wrought Iron. C. Vickers. An account of methods successfully used by the writer. 2000 w. Am Mach—Dec. 1, 1898. No. 24331.

Compression.

Feeding, or the Compressing of Metals. William Roxborough. Considers the influence certain brands of metal have upon castings, position of casting and related matters. 2000 w. Foundry—Dec., 1898. No. 24764.

Cores.

Core Prints. John M. Richardson. Describes the various prints used, offering suggestions. Ill. 1600 w. Foundry—Dec., 1898. No. 24763.

Drilling.

Drilling and Tapping Machine. A. H. Cleaves. Illustrated detailed description. 800 w. Am Mach—Dec. 22, 1898. No. 24698.

Drill Sharpening.

Rock Drill Sharpening Machines. Illustrates and describes the various British patents of these machines, with comments on the types. 1600 w. Col Guard—Dec. 9, 1898. No. 24643 A.

Forging Press.

Variable Power Hydraulic Forging Press. (Presse Hydraulique à Forger, à Puissance Variable.) Illustrated description of an English built machine giving three grades of pressure on the work. 800 w. La Revue Technique—Dec. 10, 1898. No. 24853 D.

Lathes.

The Choice of a Small Lathe. Joseph Horner. Gives details of the construction of the 5-in. lathe, with the writer's idea of details desirable in a machine, where only one lathe is owned, or can be accommodated. 2500 w. Mech Wld—Dec. 16, 1898. Serial. 1st part. No. 24783 A.

Machinery.

See Economics and Industry, Commerce and Trade.

Machine Tools.

A New Device for Boring, Milling and Tapping. (Ein Neues Verfahren zu Bohren, zu Fräsen, und mit Gewinde zu Verschen.) E. Capitaine. Describing and illustrating an improved portable tool arranged to be clamped to work in any part of the shop, thus avoiding the handling of heavy pieces. 2000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1898. No. 24800 D.

See Economics and Industry, Commerce and Trade.

Melting Iron.

Experiments in Melting Iron. Edward Kirk. From a forthcoming work on "Cupola Practice." Gives opinions formerly held, describing experiments made, and results. 3500 w. Ir Trd Rev—Dec. 29, 1898. No. 24906.

Metal Mixers.

Metal Mixers and Casting Machines. E. J. W. Richards. Abstract of a paper read at meeting of West of Scotland Iron & Steel Inst. Urges the employment of a chemist, describes the practice at the Carnegie works, refers to the Uehling casting-machine and its advantages, and gives his suggestions for manner of working in Scotland. 2400 w. Col Guard—Nov. 25, 1898. No. 24426 A.

Pig Iron.

The Yard Grading of Pig Iron. William B. Phillips. Read before the Pittsburg Foundrymen's Assn., Dec. 27, 1898. Defines the various grades, and ways of grading, giving proposed improvements. 3800 w. Ir Trd Rev—Dec. 29, 1898. No. 24905.

Pulley Accident.

Pulley Accident at Fredonia, N. Y. John E. Sweet. Describes the accident, giving illustrations showing fractures. 700 w. Power—Dec., 1898. No. 24608.

Screw Threads.

Metric Screw Threads. (Metrisches Gewinde.) A general review of the subject, with especial reference to the recent convention at Zurich. A very complete and valuable bibliography is also given. 3500 w. Zeitschr de Ver Deutscher Ing—Dec. 3, 1898. No. 24809 D.

Shafting.

Do Compressed Shafts Become Curved when Keyways are Cut in Them? (Werden Comprimirte Wellen durch das Einarbeiten von Nuten Krumm?) C. Bach. Gives the results of careful tests showing the amount by which cold-rolled shafts spring when cut for keyways, with illustrations of the apparatus used. 1000 w. Zeitschr d Ver Deutscher Ing—Nov. 12, 1898. No. 24802 D.

Stay Bolts.

Stay Bolts and Braces. L. A. Caldera. Considers the tensile strain that may be allowed, the fastening of these, stiffness of sheets, &c. Ill. 2700 w. Power—Dec., 1898. No. 24610.

Wire Nail Plant.

The Portage Iron Company, Limited. Illustrates and describes a model plant at Duncansville, Pa. 2500 w. Ir Age—Dec. 15, 1898. No. 24613.

Works Management.

Machine-Shop Management in Europe and America. H. F. L. Orcutt. This paper treats of specialization vs. generalization of equipment and products. It contrasts the American policy of close concentration upon a limited range of manufacture with the European practice of turning out many diverse products from a single works, and argues the strong influence of the former cause upon higher perfection, capacity, and economy. 3400 w. Engineering Magazine—Jan., 1899. No. 24893 B.

MATERIALS OF CONSTRUCTION.

Copper.

Concerning the Influence of Heat on the Strength of Copper. (Ueber den Einfluss der Wärme auf die Festigkeitseigenschaften von Kupfer.) M. Rudeloff. A very elaborate account of the exhaustive tests made at the government testing laboratory at Charlottenburg. 12,000 w. Mitt aus den Kgl Tech Versuchanstalt—Part IV. 1898. No. 24932 G.

Rivets.

Nickel-Steel Rivets. Summary of report of Maunsel White on important experiments made at the works of the Bethlehem Iron Co., for the purpose of ascertaining the reliability and efficiency of nickel steel for general riveting, and to observe the effect of the material at different degrees of heat. Ill. 1000 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24355 H.

Testing.

Standard Methods of Testing Cast Iron. (Einheitliche Prüfungsverfahren für Gusseisen.) Prof. A. Martens. A general discussion of the methods suggested at the conferences of the International Association, with tables, diagrams and valuable data. Two articles. 5000 w. Zeitschr d Ver Deutscher Ing—Nov. 26, Dec. 3, 1898. No. 24807 each D.

Permanent Deformation and Rupture of Metals. (Déformations Permanentes et Rupture des Métaux.) G. Faurie. A general description of tension tests of metals, with illustrations of machines employed, specifications of test pieces, physical phenomena in metals under tension, and a discussion of Tresça's laws. 7500 w. Revue de Mécanique—Nov., 1898. No. 24889 H.

POWER AND TRANSMISSION.

Air Compressor.

A Compound High-Duty Air Compressor. Il-

lustrates and describes a compressor in the service of the Indianapolis Water Co., used in raising water from a series of wells. 700 w. Am Mach—Dec. 15, 1898. No. 24620.

The Rotary Blower as an Air Compressor. Frank Richards. An explanation of the loss of power inseparable from the rotary blower and seemingly fatal to its use as an air compressor. Ill. 1500 w. Am Mach—Dec. 29, 1898. No. 24918.

Crank-Effort.

Diagrams of Crank-Effort. G. H. Shepard. Explains the method of obtaining the curves. Ill. 2500 w. Sib Jour of Engng—Dec., 1898. No. 24664 C.

Dynamo Driving.

The Use of Gas Engines for Dynamo Driving. John C. Kelley. Considers the cost of gas, the main reason why these engines are not more largely used. Discusses the cost as compared with England, and other causes affecting the sales. 1000 w. Elec Wld—Dec. 31, 1898. No. 24922.

Haulage.

Compressed Air Haulage. A description of the haulage ways, the grades, the construction of the locomotives and charging apparatus, and some figures as to economies of the plant at the Coal Brook mines near Carbondale, Pa. Ill. 2500 w. Mines & Min—Dec., 1898. No. 24367 C.

Power Measurement.

Measurement of Power with the Indicator. Explains the principle upon which most indicators work, giving illustrated descriptions of various types. 2300 w. Mech Engr—Dec. 3, 1898. Serial. 1st part. No. 24675 A.

Rope-Driving.

Ropes and Rope Driving. G. H. Kenyon. Extracts from a lecture before the Yorkshire Assn. of Engs. (England). Gives the writer's views on the subject of centrifugal tension in ropes, and discusses various difficulties in rope driving. 3500 w. Mech Wld—Dec. 16, 1898. Serial. 1st part. No. 24782 A.

Water-Power Plants.

Industrial Electro-Hydraulic Installations. (Impianti Industriali Elettro idraulichi.) Carlo Gabussi. An argument for the electrical exploitation of the numerous small water-powers in Italy, containing some data of streams, etc. 1500 w. Giorn dei Lav Pubb e delle Str Ferr—Nov. 16, 1898. No. 24851 B.

Water Power and Italian Legislation. (Le Forze Idraulichi e la Legislazione Italiana.) Report of M. Vicari and R. Pinna to the 3d. National Congress of the Società Economiche. A very full discussion of the present status of the subject. In 1897 4,259,646 tons of coal were imported into Italy, yet the great water power resources of the country are barely used. Present legislative enactments make it difficult to develop this power, and the report urges the grant of concessions to corporations under certain restrictions. It is full of valuable data. 7500 w. L'Elettricità—Oct. 30, 1898. No. 24860.

SPECIAL MOTORS.

Compressed Air.

Compressed Air Applied to Traveling Motors by a New Method. W. M. Farrar. Calls attention to a recently invented method of applying compressed air to moving motors, which it is believed will obviate most of the difficulties. Ill. 1600 w. Compressed Air—Dec., 1898. No. 24580.

Gas Engine.

Planteau Balanced Vertical Gas-Engine. (Moteur vertical Equilibré Système Planteau.) Short illustrated description of a balanced vertical, one-cylinder gas engine, specially adapted for automobile vehicles. Balance is obtained by the use of a piston in each end of the cylinder, their movements being always equal and opposite. 500 w. La Revue Technique—Dec. 10, 1898. No. 24855 D.

Gas Engines. George N. Crouse. Part first describes the Otto Method. 2000 w. Yale Sci M—Nov., 1898. Serial. 1st part. No. 24419 C.

The Problem of the Gas Engine. Herbert L. Towle. Considers the present problem is to abolish the elements of uncertainty, and to this end, the paper analyzes the factors on which ignition and combustion depend, and the methods thus far employed to control them. 3500 w. Am Mach—Dec. 1, 1898. No. 24330.

Gasoline Engines.

Gasoline and Oil Engines for Pumps. Illustrated comparison of the cost of pumping small volumes of water by internal combustion engines and steam, and a description of two water-works having kerosene-engine plants. 1200 w. Eng Rec—Dec. 24, 1898. No. 24733.

The Gasoline Engine. E. W. Roberts. Briefly discusses the nature of gasoline, the advantages and uses of the gasoline engine and the principles of construction. 1500 w. Home Study—Jan., 1899. No. 24685.

STEAM ENGINEERING.

Boiler Explosion.

Boiler Explosion at Norwich. Report of the Board of Trade investigation of the explosion at the new technical schools in course of building at Norwich, Eng., with editorial comment. 6500 w. Engng—Dec. 9, 1898. No. 24640 A.

Boilers.

On the Comparative Efficiency of Water-Tube and Water-Tank Boilers. W. George Akhurst. Points out some erroneous opinions in regard to water-tube boilers, and gives the opinion that they will never surpass the water-tank boilers in point of number. 1600 w. Prac Engr—Dec. 2, 1898. No. 24561 A.

Water-Tube Boilers. (Les Chaudières à Tubes d'Eau.) G. Humber. A general illustrated description of various types of water-tube boilers with remarks upon their handling and management. 8000 w. Ann des Ponts et Chaussées—3e. trimestre, 1898. No. 24882 E+F.

Water-tube Boilers a Necessity.—A War Lesson. J. K. Robison. Discusses the con-

ditions of the late war, and what is required to properly meet them. Considers the particulars of design in water-tube boilers required for efficiency. 5000 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24354 H.

Boiler Setting.

How to Set a Wood-Consuming Boiler. Considers the best methods for wood-consuming boilers. 1200 w. Min & Sci Pr—Dec. 24, 1898. No. 24911.

Chimney.

New York's New Chimney. Illustrates and describes a brick chimney 353 ft. high for the 70,000 H. P. Station of the Metropolitan St. Ry. Co. 1300 w. Eng Rec—Dec. 17, 1898. No. 24602.

Combustion.

The "Econometer." H. M. Kebby. Considers the production of heat from a given combustible, and gives an illustrated description of the apparatus named, which indicates continuously the exact percentage of carbonic acid contained in the escaping products of combustion. Gives also the report of the Franklin Inst. on this instrument. 4300 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24710 C.

Compound Engine.

Compound Engine in the Power-House of the Budapest Electric Railway. Brief illustrated decription of this stationary engine. From the *Zeitschrift der Vereines Deutscher Ingenieure.* 350 w. Eng News—Dec. 1, 1898. No. 24324.

Compression.

On the Compression of Steam in Engines. Is it Economical in Practice? Gives a report of Belgian, American and German experiments, with the conclusion that a certain amount of compression is desirable and economical. 3000 w. Engr, Lond—Nov. 25, 1898. No. 24432 A.

Engineering Plants.

Modern Practice in the Engineering Plants of Large Buildings. William H. Bryan. Extract from an address delivered before the St. Louis Chapter of the Am. Inst. of Archt's. An outline of the writer's views as to what is good practice. 2000 w. Am Arch—Dec. 24, 1898. No. 24765.

Feed Water Purification.

Purification of Boiler Feed Waters by Heat. (Epuration des Eaux d'Alimentation des Chaudières par la Chaleur.) A general description of methods and apparatus, illustrated with details of the Buron apparatus, with data of heat required for precipitation of calcareous matters. 1800 w. Le Génie Civil—Dec. 3, 1898. No. 24865 D.

Firing.

Fuel and Furnaces. C. E. Lake. Discusses means of reducing waste, especially by the labor employed. 1200 w. Elec Engng—Dec., 1898. No. 24714.

Flow of Steam.

Formulæ for Flow of Steam Through Pipes. R. C. Carpenter. Investigations, with explanations of tables given. 2200 w. Sib Jour of Engng—Dec., 1898. No. 24666 C.

Friction Brake.

Prony's Friction Brake. William Barnet Le Van. From *Power and Transmission.* Gives briefly the history of this invention with description of the brake and the recent improvements. 2000 w. Mech Wld—Dec. 16, 1898. No. 24781 A.

Mechanical Draft.

The Cost of Mechanical Draft Plant. Walter B. Snow. Discusses the primary cost of the plant and the fixed charges as compared with those incident in the employment of a chimney. 1800 w. Ir Age—Dec. 1, 1898. No. 24334.

Piping.

The Design of Piping for Electric Power Houses. Illustrated description of the best methods of piping and of faults to be avoided. 6000 w. Eng Rec—Dec. 17, 1898. No. 24603.

Smoke.

Smoke. Editorial discussion of the recent agitation in England over the smoke prevention question. 2000 w. Engr, Lond—Dec. 9, 1898. No. 24650 A.

The Law and Practice of Smoke Prevention. Comments on the agitation of this subject by Sir W. B. Richmond, and the results of experiments made for the purpose of furnishing a basis of comparison. 2300 w. Jour Gas Lgt—Dec. 6, 1898. No. 24614 A.

Standards.

Engine Proportions. James Christie. Reasons why it is difficult to make them always conform to an arbitrary standard. Especially considers shafts and bearings of engines. 1200 w. Am Mach—Dec. 15, 1898. No. 24619.

Superheated Steam.

Superheated Steam and Its Application on Steam Engines. Paul Schou. Abstract from a paper read before the Northern Soc. of Elec. Engs., England. Describes the Schmidt tandem compound engine and the superheater. 2200 w. Ind & Ir—Dec. 9, 1898. No. 24637 A.

Thermal Efficiency.

Thermal Efficiency of Steam-Engines. R. H. Thurston. Abstract and summary of conclusions of the committee of the British Inst. of Civ. Engs. in their report on this subject. 1600 w. Science—Dec. 2, 1898. No. 24378.

Valve.

Intercepting Valve for Compound Locomotives. Illustrates and describes the intercepting valve for the Cooke compound, the object of which is to convert an engine from a compound to a simple, and to permit the engine to run simple for any length of time. 700 w. Loc Engng—Dec., 1898. No. 24399 C.

MISCELLANY.

Bicycles.

On the Steering of the Bicycle. G. T. McCaw. An investigation of the causes which affect steering, with a view to determining the best design of the steering head. 2000 w. Engr, Lond—Dec. 9, 1898. No. 24648 A.

Relation between Forward Movement and Lateral Inclination of a Bicycle. (Relation qui

Existe, dans la Bicyclette roulant sur un Sol Horizontal, entre la Mouvement de Progression et le Mouvement d'Inclinaison.) J. Boussinesq. A mathematical study of this relation which is finally defined in a differential equation of the second degree. 1200 w. Comptes Rendus—Nov. 28, 1898. No. 24850 D.

China and Japan.

Observations of an American Engineer in China and Japan. August C. Christensen. The condition of machine works in these countries is discussed, and other things observed by the writer. 2200 w. Am Mach—Dec. 15, 1898. No. 24621.

Flying Machines.

Flying Machines and Ordnance. Hiram Maxim. Delivered before the Engng. Soc. of Columbia Univ. of the City of N. Y. Relates experiments with flying machines, and his work on rapid-firing guns and smokeless powder. 2500 w. Sci Am—Dec. 24, 1898. No. 24700.

Mechanical Units.

Notes on the Definitions of Some Mechanical Units. William Kent. Read before the session of Mech. Science and Engng. of the Am. Assn. for the Adv. of Science, at Boston. Discusses the difference of opinion existing between physicists and engineers in regard to definitions of commonly used terms. 1800 w. Eng News—Dec. 1, 1898. No. 24328.

Refrigeration.

Ammonia Absorption System of Refrigeration. H. F. Stanley. Considers the construction of the generator, and separator, the importance of the economizer, &c. 2400 w. Ice & Refrig—Dec., 1898. Serial. 1st part. No. 24393 C.

Russia.

Engineering in Russia and the Use of Naphtha for Fuel in Russia. Alexis Gatzook and Stephen Goulishambaroff. Information concerning the mechanical industries, fuel, &c. Ill. 3000 w. Power—Dec , 1898. No. 24609.

Slide Rule.

The Slide Rule. Edwin H. Lockwood. Describes the slide rule and its use. 2000 w. Yale Sci M—Nov., 1898. No. 24418 C.

Tire Repairing.

Practical Hints from a Tire-Repair Shop. B. F. Fells. Discusses the treatment of punctures, and the methods of sewing tires. Ill. 1000 w. Ind Rub Wld—Dec. 1, 1898. No. 24344 D.

MILITARY ENGINEERING.

Aluminum.

Use of Aluminum in Warfare by the Armies and Navies of the World. From *The Aluminum World*. Discusses how aluminum could be used to advantage. 2200 w. Sci Am Sup—Dec. 17, 1898. No. 24575.

American Navy.

Effect of the Late War on the American Navy. Editorial discussing the effect on war material, gunnery, &c. 1500 w. Engr, Lond—Dec. 16, 1898. No. 24743 A.

Armor Plates.

Beardmore Process Armor-Plates. Brief report of a severe test of plates supplied to the Danish Government by Messrs. Beardmore, Glasgow. 700 w. Engr, Lond—Nov. 25, 1898. No. 24482 A.

Army Supply.

Our Army Supply Departments and the Need of a General Staff. John H. Parker. Discusses the quartermaster, commissary, and ordnance departments, and their work in the war with Spain, and offers recommendations tending toward the improvement of that military service. 9300 w. Am Rev of Revs—Dec., 1898. No. 24389 C.

Artillery.

The Artillery in Battle. John P. Wisser. A discussion of tactics considering the attack, the defense, night combats, rapid-fire guns, &c. 3800 w. Jour of U. S. Art—July, Aug., 1898. No. 24376 D.

Battleship.

The First-Class Battleship "Maine." An accurate engraving, with description of the new battleship bearing this name. 1800 w. Sci Am—Dec. 3, 1898. No. 24336.

Battleship Plant.

Electrical Equipment of the U. S. Battleship "Oregon." Alex. J. Dickie. Gives a summary of the features of the ship with detailed description of her electrical equipment. Ill. 1700 w. Am Elect'n—Dec., 1898. No. 24474.

British Navy.

Naval Expenditure. Editorial discussion of the Board of Trade return for 1897, giving comparison with other countries, and information of interest. 2000 w. Engng—Dec. 16, 1898. No. 24746 A.

Classification.

Classification of War Ships and Torpedo Boats. J. Foster Symes. Explains on what classification depends, and describes the various types. 1800 w. Yale Sci M—Nov., 1898. No. 24420 C.

Cruiser.

The Argentine Armored Cruiser "General Belgrano." Illustrates and briefly describes this sister ship to the "Christobal Colon." 600 w. Sci Am Sup—Dec. 17, 1898. No. 24574.

Engineering in the Navy.

Electrical and Engineering Work in the Navy During the War. W. D. Weaver. Reviews the various applications that would add to the efficiency and general comfort of a man-of-war, citing successful applications and those that have failed or not yet been tried. 1500 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24672.

Gibraltar.

Defensive Works in Progress at Gibraltar.

Works for the extension of moles and dock accommodation, and strengthening of the land defences are in progress. Notes on these and other works are given. 1400 w. Engr, Lond—Dec. 2, 1898. No. 24531 A.

Gun Carriages.

The Development of Carriages for Rapid-Fire Guns. (Die Entwickelung der Schnellfeuer-Feldlaffeten.) J. Castner. With details of carriages, and reproductions of photographs of some of the latest forms of German field artillery. 3500 w. Stahl und Eisen—Dec. 1, 1898. No. 24928 D.

Naval Corps.

The necessity for a Naval Electrical Engineer Corps. F. W. Roller. Arguments in favor of electric motors on American battle-ships, and the need of a corps of electrical engineers for the navy. 12,000 w. Elec Eng, N. Y.—Dec. 29, 1898. No. 24937.

Naval Engineers.

The Fighting Engineers at Santiago. Arthur Warren. A well illustrated account of the excellent work of the U. S. naval Engineers in the Santiago campaign and in the great battle with the Spanish squadron. The author shows how large a part was played by the engineers, who should no longer be considered as non-combatants, and how it was through their efforts that the brilliant victory was won. The article contains numerous intimate details of the life of the engineers at sea, the work of engine and fire-room forces in battle, and speaks of the condition of the motive power of some of the U. S. vessels during the engagement. It is written in vigorous and picturesque style. 4200 w. Engineering Magazine—Jan., 1899. No. 24892 B.

Naval Machinery.

Material for Naval Machinery. A copy of the specifications issued by the Bureau of Steam Engineering of the Navy Dept., for the inspection of material for use in the construction of machinery for the U. S. Navy. 4800 w. Ir Age—Dec. 8, 1898. No. 24462.

With the Machinery of a War-Ship During Action. B. S. Notes on the conditions of the engine-room during an engagement, showing that there is room for improvement in the arrangement of machinery. 1600 w. Prac Engr—Dec. 9, 1898. No. 24776 A.

Naval Personnel.

The Reorganization of the Naval Personnel. A symposium including 1. The suggestion of a solution, by Francis H. Wilson; 2. The genesis of the personnel bill, by Theodore Roosevelt; 3. A line officer's view, by John W. Philip; 4. An engineer officer's view, by George W. Melville; and 5. From the standpoint of the people, by George Edmund Foss. 20,000 w. N Am Rev—Dec., 1898. No. 24385 D.

Navies.

Comparative Strength of the World's Navies. A comparison to show the position of the U. S. in naval strength. Ill. 2300 w. Sci Am—Dec. 31, 1898. No. 24941.

Navy Engineering.

Applied Science in the Navy. R. H. Thurston. Comment on information in the report of the Chief of the Bureau of Steam Engng. of the Navy Dept. of the U. S. on the work performed during the war with Spain. 1300 w. Science—Dec. 9, 1898. No. 24476.

Ordnance.

Forthcoming Improvements in United States Naval Ordnance. G. L. Carden. Discusses changes to be made in guns and mounts and in the make up of the ships' batteries. 2000 w. Sci Am—Dec. 17, 1898. No. 24572.

Shell.

The Manufacture of Shell for the United States Navy. Rudolph E. Bruckner. Illustrates and describes the work, showing the exactness necessary, and the describing method of inspection. Considers the manufacture of the 5-inch cast iron shell. 2000 w. Am Mach—Dec. 29, 1898. No. 24916.

Steam.

Steam in the Navy and Naval Engineering. Abstracts from the report of Engineer-in-Chief of the Navy, Commodore G. W. Melville, showing the part played by the mechanical engineer and machine-constructor in modern naval wars. 5000 w. Sib Jour of Engng—Dec, 1898. No. 24665 C.

Submarine Boats.

Submarine Torpedo Boats: Their Influence on Torpedo Boat Architecture and Value in Warfare. William H. Jaques. Read at session of the Inst. of Naval Archt's., London. Reviews the history of past experience, describing the boats built under Mr. Holland's direction, also the "Plunger" and "Holland." Ill. 3300 w. Marine Engng—Dec., 1898. No. 24545 C.

Torpedo Boats.

Electrical Propulsion for Torpedo Boats. Charles T. Child. A discussion of the present possibilities of electric torpedo boats, showing them to be fitted for satisfactory work, and stating their advantages. 2400 w. Jour of Am Soc of Nav Engs—Nov., 1898. No. 24351 H.

Full Details of Sixteen Torpedo Boats to be Built for the United States Government. 2400 w. Engng Mech—Nov., 1898. No. 24396 C.

The Torpedo-Boat Family. (La Famiglia Torpediniera.) Lieut. G. Roncagli. An extended history of torpedo and torpedo-boat warfare with much interesting information concerning early torpedo exploits. The author argues for the superiority of the gun over all other weapons. He believes the extension of ranges and powers of artillery minimizes the effectiveness of torpedo-boats discharging automobile torpedoes, as these are essentially close-range weapons. The paper is remarkable not only for its argument but for the literary style it displays. 11,000 w. Rivista Marittima—Nov., 1898. No. 24875 H.

War Study.

Introduction to the Study of the War between Turkey and Greece. C. F. von der Goltz. Discusses the main object and original plans of campaign of the Turks. 3000 w. Jour of U. S. Art—July-Aug., 1898. Serial. 1st part. No. 24377 D.

MINING AND METALLURGY.

COAL AND COKE.

Coal Dust.

Rendering Coal Dust Non-Dangerous in the Saar District. From an official report by Bergassessor Dröge, Saarbrücken. The removing of the dust in this colliery was proved impracticable, and the methods of damping are described, and the advantages and disadvantages discussed. 6500 w. Col Guard—Dec. 9, 1898. No. 24642 A.

Coal Testing.

Coal Testing and Analysis. Camille Matignon. From a communication to the Second International Congress of Applied Chemistry. Reviews the factors which intervene in the examination of a coal, showing the advantage of introducing the calorific power into the clauses of a coal contract, and the utility of the Mahler shell. 3000 w. Col Guard—Nov. 25, 1898. No. 24429 A.

Coking.

The Coking of Inferior Coals with the Aid of Pressing Machines. Partly translated from *Stahl und Eisen* and partly gathered from the records of the English Patent Office. Briefly notes the methods tried, and the degree of success, with illustrated description of various machines. 4000 w. Ir & Coal Trds Rev—Dec. 16, 1898. No. 24735 A.

The Coking of Lean Coals. (Ueber die Verkokung Magerer Steinkohlen.) O. Simmersbach. A description of a method of compressing coal slack into coherent masses for coking in special ovens. 2500 w. Stahl und Eisen—Dec. 1, 1898. No. 24930 D.

Consumption.

Coal and Coke Consumption for Different Purposes in France, Belgium and Germany. Statistics showing the increase and activity in these industries. 900 w. Col Guard—Dec. 2, 1898. No. 24522 A.

Indian Coals.

The Distribution, Methods of Working, and quality of Indian Coals. Information on the occurrence and working of Indian Coal, taken from the report of W. R. Durstan to the Imperial Inst. 3300 w. Ir & Coal Trds Rev—Dec. 2, 1898. No. 24569 A.

Scotch Coals.

Scotch Coals in the Manufacture of Iron and Steel. F. W. Paul. Abstract of a paper read before the West of Scotland Iron and Steel Inst. Gives results of analyses and some practical results of the consumption of fuel in coal-fired heating furnaces and the boiler-evaporative duty. 2800 w. Ir & Coal Trds Rev—Nov 25, 1898. No. 24424 A.

Subsidence.

Subsidence Due to Coal Workings. Abstract of a paper by S. R. Kay, read at meeting of the Inst. of Civ. Engs., England. In designing works for mining districts the importance of knowing the principles of subsidence, the approximation to the area necessary to be left unworked, and how the design may be suited to the possibility of the coal being worked without leaving solid pillars for support. 1400 w. Col Guard—Dec. 2, 1898. No 24523 A.

Washington.

Coal Mining in Washington. The situation and particulars in relation to the history and methods of working of the mines of the Northern Pacific Coal Co. at Roslyn and the mines of Kittitas County. Ill. 3000 w. Mines & Min—Dec., 1898. No. 24366 C.

COPPER.

British Columbia.

Copper Mining at Kamloops, B. C. W. M. Wade. An account of the discovery and the value of the deposits. 900 w. Eng & Min Jour—Dec. 10, 1898. No. 24512.

Copper Deposits.

A New Copper Region. J. C. Kennedy. Report of the deposits on or near the boundary between Wyoming and Colorado. Briefly describes some of the claims. 2200 w. Min Rept—Dec. 1, 1898. No. 24460.

Copper Ore.

Copper Traces in Bucks and Montgomery Counties. Benjamin Smith Lyman. A record of the location and mode of occurrence of these traces, which are not workable, with the idea of preventing waste of money on deposits practically worthless. Map. 2300 w. Jour Fr Inst—Dec., 1898. No. 24465 D.

Smelting.

Copper Smelting in Wales. W. Terrill. Gives the operations as outlined in Percy's "Metallurgy of Copper," and describes the modifications which have been adopted in the present practice. 3300 w. Eng & Min Jour—Dec. 3, 1898. No. 24400.

GOLD AND SILVER.

Alaska.

The Yukon Country. P. T. Rowe. Abstract of a lecture delivered at Sitka, Alaska. An account of the changes so rapidly wrought, and of the mining conditions and general outlook. 4500 w. Chau—Jan., 1899. No. 24757 C.

Butte, Montana.

The Mining Industry of Butte, Montana. Wascott. Describes the location and the working of the silver and copper mines. Ill. 2700 w. Min & Sci Pr—Dec. 3, 1898. No. 24478.

Colorado.

Mines of the La Plata Mountains, Colorado. R. W. Petre. Describes the location, geology, and mines. Ill. 1400 w. Eng & Min Jour—Dec. 3, 1898. No. 24401.

Concentration.

An Improved Blanket-Table. Thomas White. Before the Australasian Inst. of Min. Engs. Gives a description of improvements for

simplifying the working of blanket-tables, and supplying a cheap and easily worked concentrator. Also discussion. Ill. 2200 w. Can Min Rev—Nov. 30, 1898. No. 24416 C.

A Means of Economizing Water in Concentration. Edward H. Johnson. Brief illustrated description of apparatus and method. 700 w. Jour of Chem & Met Soc of S. Africa—Oct., 1898. No. 24504 E.

Crushing.

Dry Crushing at a South African Gold Mine. (Luipaard's Vlei Estate and G. M. Co., Ltd.) George H. Furner. Describes the process and gives points in favor of dry crushing. Ill. 1400 w. Min & Sci Pr—Dec. 10, 1898. No. 24581.

Notes on Dry and Wet Crushing. Frank Merricks. Read before the Inst. of Min. and Met., London. A discussion of the best treatment for different kinds of ores. 1800 w. Col Guard—Dec. 9, 1898. No. 24645 A.

Cyanide.

Some Notes on the Recovery of Gold from Cyanide Solutions. Sherard Cowper-Coles. Reports results obtained from gold cyanide solutions of varying strengths with aluminum cath odes and iron anodes. 1600 w. Min & Sci Pr —Nov. 26, 1898. No. 24340.

Gold Fields.

One of the World's Gold Fields—The Silver Peak Mines. S. A. Knapp. An account of these mines in Nevada, whose recent extensive developments have attracted attention. 1500 w. Min & Sci Pr—Nov. 26, 1898. No. 24341.

The Alaskan Gold Fields and the Opportunities They Offer for Capital and Labor. Samuel C. Dunham. Report of recent investigations in these mining districts, showing what progress is being made, and the need of taking every precaution in going to this region. 23500 w. Bull of U. S. Dept. of Labor—Nov., 1898. No. 24348 D.

The Gippsland Gold Fields, Victoria. H. Herman. A brief description of the relations of the silurian and some of the later formations in the lower portion of the Mitchell River Valley, with some probable reasons for the difference in their metalliferous contents. 4200 w. Aust Min Stand—Nov. 3, 1898. No. 24457 B.

Gold Ores.

Mining and Milling Gold Ores in Western Australia. H. C. Hoover. A description of this gold field, the mining companies, mines, milling, costs of working, etc. 3300 w. Eng & Min Jour—Dec. 17, 1898. No. 24615.

Gold Thefts.

Gold Thefts and Illicit Gold Buying on the Rand. A. von Dessauer. Considers measures for overcoming this evil. 2000 w. Jour of Chem & Met Soc of S. Africa—Oct , 1898. No 24507 E.

Gold Veins.

Gold Veins in the San Diego Region. Arthur Lakes. Describes mine camps among orange groves and within view of the Yuma Desert and Death Valley. 1200 w. Mines & Min—Dec., 1898. No. 24370 C.

Mine Fuel.

Fuel at the Caylloma Mines, Peru. Bernard Hunt. Abstract of paper read before the Inst. of Min. & Met., London. The fuel used at these silver mines, the cost, and purposes for which it is used. 1000 w. Eng & Min Jour—Dec. 17, 1898. No. 24616.

Precious Metals.

The Mining and Minting of Gold and Silver. Alexander E. Outerbridge, Jr. A review of the last thirty years, the processes recently employed, coining, etc. 6000 w. Jour Fr Inst—Dec., 1898. No. 24464 D.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. T. L. Carter. A valuable contribution to the question of zinc or electrical precipitation. Discussion opened and to be continued at next meeting. 3500 w. Jour of Chem & Met Soc of S. Africa—Oct., 1898. No. 24505 E.

Silver Field.

A New Australian Silver Field. John Plummer. Brief account of recent discoveries in New South Wales. 600 w. Eng & Min Jour —Dec. 10, 1898. No. 24513.

Slimes.

Discrepancies in Slime Treatment. W. A. Caldecott. Continued discussion of Mr. Caldecott's paper, with the writer's reply. 3000 w. Jour of Chem & Met Soc of S. Africa. Oct., 1898. No. 24506 E.

Slimes Treatment in Montana. Matt W. Alderson. Describes an agitation system where flocculation or coagulation and subsequent settling of the slimes are secured, and the gold afterwards precipitated on zinc shavings. In use at the Schmidt & John's mill, at Silver Star, Montana. 1000 w. Eng & Min Jour—Dec. 24, 1898. No. 24771.

Smelting.

The Smelting of Gold and Silver Ores in British Columbia. A statement of the situation of the smelting business in British Columbia, with a discussion of the remedies. 2000 w. Can Min Rev—Nov. 30, 1898. No. 24414 C.

Victoria.

Mining in Victoria. An interesting account of this mining region of Australia, illustrating the primitive methods of alluvial gold mining and extraction, and the progress in methods. 2000 w. Aust Min Stand—Nov. 10, 1898. Serial. 1st part. No. 24655 B.

IRON AND STEEL.

Annealed Steel.

Brittleness Produced in Soft Steel by Annealing. John Edward Stead. Read before the Iron and Steel Inst., at Stockholm. Discusses this peculiarity, its cause and how to prevent it. Ill. 6400 w. Jour Am Soc of Nav Engs—Nov., 1898. No. 24352 H.

Arctic Ores.

Mining the Iron Ores of Arctic Europe. David A. Louis. This interesting article de-

scribes the mines and mining methods of the Aktiebolaget Gellivare Malmfält in northern Sweden. The mines are located within the Arctic circle, and work the colossal ore deposits of that region. The mines are generally open cuts and the ore very hard, dynamite being used to blast it out. Highly modern methods are used, the hauling being accomplished by electric locomotives in most cases. Two maps and many fine illustrations accompany the article. 3700 w. Engineering Magazine—Jan., 1899. No. 24898 B.

Basic Steel.

The Basic Open-Hearth Process in Westphalia. (Der Basische Martin process in Westfalen.) Karl Johansson. A general account of the basic open-hearth practice, with data as to the product and methods. Two articles. 4000 w. Oesterr Zeitschr f Berg u Hüttenwesen—Nov. 12, 19, 1898. No. 24823 each B.

Blast Furnaces.

Blast Furnaces December 1, 1898. Tabulated statement of the number and capacity of furnaces in and out of blast in the United States. 1200 w. Am Mfr & Ir Wld—Dec. 9, 1898. No. 24547.

The Blast Furnace as a Source of Power. Horace Allen. From a paper read before the South Staffordshire Inst. of Iron and Steel Works' Managers. Discusses steps in economic progress, especially the use of waste gases. 4500 w. Col Guard—Dec. 16, 1898. No. 24739 A.

Brinell's Chart.

Brinell's Chart of Changes of Fracture and Carbon in Steel. A graphical representation of changes in steel containing 75% of carbon while heating and cooling, with description and rules for treating steel. 1600 w. Eng & Min Jour—Dec. 24, 1898. No. 24770.

Convention.

The General Convention of the Society of German Iron Masters at Düsseldorf. (Die Haupsversammlung des Vereines Deutscher Eisenhütten leute zu Düsseldorf am 23 Oktober, 1898.) A very full report of the proceedings at this important meeting, with abstracts of the papers. Two articles. 10,000 w. Zeitschr d Ver Deutscher Ing—Nov. 19, 26, 1898. No. 24804 each D.

Gun Iron.

Making of Gun Iron and Semi-Steel. Titus Ulke. Gives results of recent practice in the foundries of the United States. 3000 w. Ir Trd Rev—Dec. 1, 1898. No. 24342.

Iron and Steel.

The Metallurgy of Iron and Steel. A. Humbolt-Sexton. Part first discusses the importance of iron, chemical and physical properties, magnetism, iron oxides, &c. 2700 w. Mech Engr—Nov. 26, 1898. Serial. 1st part. No. 24654 A.

Iron Ores.

The World's Chief Deposits of High-Class Iron Ores. An account of the chief iron-ore deposits of the world with illustrations of the workings. 3000 w. Ir & Coal Trds Rev—Nov. 18, 1898. No. 24322 A.

Iron Trade.

The American Iron Trade in Ireland. Willard S. Mattox. Information relating to the trade in Belfast. 1500 w. Ir Age—Dec. 1, 1898. No. 24333.

Pig Iron.

The Costs of Pig Iron in Relation to the Ore. Walter J. May. Considers the reasons why America can deliver pig-iron in England at a lower price than the British product, and offers suggestions to mine owners and iron smelters. 900 w. Mech Wld—Dec. 2, 1898. No. 24555 A.

The Cost of Producing Pig Iron in Alabama. William B. Phillips. From advance sheets of "Iron-Making in Alabama." Statistics of cost of raw material, and of manufacture, with related matter of interest. 2500 w. Am Mfr & Ir Wld—Dec. 2, 1898. No. 24470.

See Economics and Industry, Commerce and Trade.

Rolling Mills.

Progress in Rolling Mill Construction. (Die Fortschritte in den Walzwerkseinrichtungen.) Max Meier. A long paper before the Verein Deutscher Eisenhüttenleute, describing the rolling mills at Micheville. Interesting data about electric driving are given. 4500. Stahl und Eisen—Nov. 15, 1898. No. 24927 D.

The Sack Universal Rolling Mill for Beams. (Sacksches Universal-Trägerwalzwerk.) A description of an improved form of mill with both vertical and horizontal rolls, by use of which I beams of various sizes may be rolled. 1200 w. 1 plate. Stahl und Eisen—Dec. 1, 1898. No. 24929 D.

Russian Iron.

See Economics and Industry, Commerce and Trade.

MINING.

Air Doors.

Automatic Colliery Air Doors. Illustrates and describes automatic doors, arranged to remain closed except when trucks are required to pass. 350 w. Engr, Lond—Dec. 2, 1898. No. 24529 A.

Dynamite.

The Handling of Dynamite. Points from the report of mine inspector Byrne of Montana. 1400 w. Min & Sci Pr—Dec. 17, 1898. No. 24695.

Explosives.

Explosives—Ancient and Modern. W. J. Orsman. Lecture delivered at the Wigan Mining School. Discusses the action of various explosives, the progress, and their use in mining and in purposes of war. 1200 w. Col Guard—Dec. 9, 1898. No. 24646 A.

The Position of Safety Explosives Abroad. Translated and abridged from the *Annales des Mines de Belgique*. Defines what is understood by a "safety explosive," and reviews what has been done to determine whether given explosives satisfy the conditions. 2100 w. Ir & Coal Trds Rev—Dec. 2, 1898. Serial. 1st part. No. 24570 A.

Fans.

The Fan. C. H. Innes. Gives an outline of the experiments conducted by the Prussian Mining Commission in 1884, and gives illustrated descriptions of various types. 2000 w. Prac Eng—Nov. 18, 1898. No. 24310 A.

Firedamp.

The Firedamp and Coal Dust Explosions in 1897. (Die im Jahre 1897 Erfolgten Schlagwetter and Kohlenstaub Explosionen.) With especial reference to the Westphalia district, giving details of the most important instances. 3500 w. Glückauf—Nov. 12, 1898. No. 24825 B.

Flooded Workings.

A Danger in Flooded Workings. Sketches a condition of things with regard to magnetically hinged surveys made in the half century of years between 1790 and 1840, and comments on the dangers that may now exist. 3500 w. Col Guard—Dec. 9, 1898. No. 24647 A.

Indicators.

Notes on Indicators, Feeders, etc. W. Pearce. Results of observations in prospecting. Ill. 1800 w. Aust Min Stand—Nov. 10, 1898. No. 24656 B.

Life Saving.

Methods of Life Saving in Mining. (Das Rettungswesen im Bergbaubetriebe.) H. Rössner. Especially devoted to the systematic method used in the Ostrau-Karwin coal district, describing apparatus, precautions and the very complete system of signals. 6000 w. Glückauf—Dec. 10, 1898. No. 24827 B.

Management.

Mine Management in the Kanawha Valley. Carl Schotz. Read before the West Virginia Coal Exchange. Discusses particularly economical methods of working. 2000 w. Mines & Min—Dec., 1898. No. 24371 C.

Mine Disasters.

Fatal Disasters in the Prussian and British Coal Mines in 1897. (Die Tödtliche Unfälle im Preussischen und Britischen Steinkohlen bergbau wahrend des Jahres 1897.) With comparative tables for preceding years, and various districts. 3000 w. Glückauf—Nov. 12, 1898. No. 24824 B.

Umpire Mine Disaster. William Seddon. A description of the work of rescue; also the report to the governor by Robert Brownlee, Chief of Bureau of Mines. 3000 w. Mines & Min—Dec., 1898. No. 24369 C.

Mine Timber.

The Hasselmann Pickling Process for Mine Timber. Max Krause. From a paper read before the Munich Bergmannstag. Considers how industries that use wood, especially the mining interest, can best and longest maintain it in a condition fit for use. 2500 w. Col Guard—Dec. 2, 1898. No. 24521 A.

Mine Valuation.

Mine Valuation from an Investor's Standpoint. A discussion of methods of approximating the present value of a mine. 1600 w. Can Min Rev—Nov. 30, 1898. No. 24415 C.

The Examination and Valuation of Mines. Alfred Harper Curtis. Abstract of paper contributed to the New Zealand Inst. of Min. Engs. A summary of the points in mine examinations on which the writer laid especial stress, with brief report of discussion. 1600 w. N. Z. Mines Rec—Oct. 17, 1898. No. 24423 B.

Pumping Plant.

Electric Underground Drainage Plant of 800 Horse Power. (Elektrischer Autrieb einer Unterirdischen Wasserhaltung von 800 P. S.) O. Lasche. A very full account of the electric pumping plant of the "Maria," "Anna," and "Steinbank" mines at Höntrop near Bochum, Westphalia. 4500 w. 1 plate. Zeitschr d Ver Deutscher Ing—Dec. 3, 1898. No. 24808 D.

Timbering.

Timbering and Supporting Underground Workings. George L. Kerr. Abstract of paper read at a general meeting of the Mining Inst. of Scotland. Discusses timbering and its cost, steel and iron supports, brick walls and girders, and strength and preservation of timber. 3500 w. Ir & Coal Trds Rev—Dec. 16, 1898. No. 24736 A.

MISCELLANY.

Aluminum.

Aluminum on Its Mettle. A lengthy illustrated description of the works of the British Aluminum company, with information of this metal and its usefulness. 10800 w. Commerce—Dec. 14, 1898. No. 24726 A.

British Law.

Mines and Minerals Under and Adjacent to Waterworks. A statement of British law and report of cases. 3000 w. Col Guard—Dec. 9, 1898. No. 24644 A.

Cobalt.

The Treatment of Cobalt and Other Similar Ores. Walter J. May. The importance of classifying the material, and the need of securing the ore in the best condition possible. Gives suggestions for economical treatment. 1600 w. Col Guard—Nov. 25, 1898. No. 24427 A.

Mica.

Mining and Marketing Mica. Illustrates an East India mica mine, and the preparation of the plates, giving information relating to this product. 1200 w. Min & Sci Pr—Nov. 26, 1898. No. 24339.

Mineral Exhibit.

Minerals and Mining at the Omaha Exposition. Marcus Benjamin. An interesting description of this exhibit showing the mineral wealth of the United States. 2800 w. Eng & Min Jour—Dec. 10, 1898. No. 24510.

Mineral Output.

The Mineral Output of the United Kingdom. Particulars concerning each kind of mineral, as given in report of Dr. Foster. 4000 w. Col Guard—Nov. 25, 1898. No. 24425 A.

Nickel.

Nickel Deposits Near Riddles, Oregon. W.

L. Austin. Abstract of paper read before the Colorado Scientific Society. Relates circumstances of the discovery and describes the deposits. 1000 w. Mines & Min—Dec., 1898. No. 24372 C.

Salt.

Louisiana Salt Resources. A. F. Lucas. An account of the discovery and working of deposits of rock salt of great purity in a series of islands on the Gulf Coast. 3300 w. Am Mfr & Ir Wld—Dec. 23, 1898. No. 24766.

Smelting.

Smelting in Germany. Henry Watson. Describes the process of smelting zinc-lead ores, as carried on at the Herzog Julius and Frau Sophien works, situated on the borders of the Harz Mountains. 1200 w. Aust Min Stand—Nov. 3, 1898. No. 24456 B.

Tin.

The Malay Tin Industry. Shows this to be by far the largest tin producing country in the world, and describes the deposits, mining, etc. 3000 w. Ir Age—Dec. 8, 1898. No. 24463.

Tasmanian Tin Deposits. H. Grant. The history of tin mining on the Blue Tier formations. 2000 w. Aust Min Stand—Nov. 17, 1898. No. 24658 B.

The Herberton Tin-Fields. W. S. Dowel, in the *Brisbane Courier*. Information concerning these lode tin deposits in Queensland. 1200 w. Aust Min Stand—Nov. 17, 1898. Serial. 1st part. No. 24657 B.

Turquoise.

A Turquoise Deposit in Mohave County, Arizona. A. B. Frenzel. An account of a deposit uncovered in Aug., 1898. 700 w. Eng & Min Jour—Dec. 10, 1898. No. 24511.

MUNICIPAL ENGINEERING.

GAS SUPPLY.

Accounts.

The Balance-Sheet. J. H. Brearley. Read at meeting of the Manchester Dist. Inst. of Gas Engs. Considers the methods and their faults and the various items. 3300 w. Jour Gas Lgt—Nov. 29, 1898. No. 24480 A.

Acetylene.

Acetylene Gas Generator. Sketches with brief description of Exley's acetylene gas generator. The form of construction is what is known as a displacement holder. 350 w. Engr, Lond—Dec. 2, 1898. No. 24534 A.

Acetylene Regulations and Insurance. Copy of the regulations recently adopted by the fire department of New York City, for the transportation, sale and use of calcium carbide. 1200 w. Met Work—Dec. 10, 1898. No. 24503.

Acetylene v. Ethylene. An explanation of the present state of knowledge on the subject of carbides and the gas ethylene, with a comparison of its illuminating power with acetylene. 1500 w. Engr, Lond—Dec. 16, 1898. No. 24741 A.

Town Lighting with Acetylene. Results at Wabash (Ind.), New Milford (Conn.), Milford (Pa.), and Cowdenbeath (Scotland), are given. Ill. 2800 w. Pro Age—Dec. 1, 1898. No. 24346.

Calcium Carbide.

An Account of the First Production of Calcium Carbide and Acetylene in the United States. F. P. Venable. Relates the beginning of the production of this substance at Spray, N. C. 900 w. Am Mfr & Ir Wld—Dec. 16, 1898. No. 24624.

The Calcium Carbide Industry. Report of recent progress dealing with the production, utilization, properties and tests. 3000 w. Engng—Dec. 9, 1898. No. 24641 A.

Dellwik Process.

The Dellwik Water Gas Process. M. Geitel. Translated from the *Polytechnisches Centralblatt*. Brief review of the changes in the history of water-gas. 1400 w. Pro Age—Dec. 1, 1898 No. 24345.

Gas Holder.

The Failure of a Large Gas Holder in New York City. Views of the wreck showing the complete destruction, with explanation of the construction. 800 w. Eng News—Dec. 22, 1898. No. 24681.

Lamp Chimneys.

Chimneys for Incandescent Gas Lamps. Ernest M. White. An account of experiments made with various forms of chimney, with illustrated description of an invention of the writer. 1000 w. Jour Fr Inst—Dec., 1898. No. 24468 D.

Lewes' Method.

Lewes' Method and Apparatus for Manufacturing Gas. Description as given in the patent specification. Ill. 3000 w. Am Gas Lgt Jour—Dec. 26, 1898. No. 24769.

Public Institutions.

Gas v. Electricity for Lighting Public Institutions. Abstract of an article by Carlton Lambert, contributed to *The Hospital*. Gives the relative cost of each at London prices, and generally favors the Welsbach light. 1200 w. Jour Gas Lgt—Dec. 13, 1898. No. 24674 A.

Purification.

Purification. A discussion before the Manchester District Inst. of Gas Engs. 7000 w. Jour Gas Lgt—Nov. 29, 1898. No. 24479 A.

Sheffield, Eng.

Gas Works Extensions at Sheffield. Detailed description of the new station. 3200 w. Gas Wld—Nov. 19, 1898. No. 24315 A.

Sulphur Test.

The Double Sulphur Test for Bisulphide of Carbon. S. Carpenter. Gives a description of this test and the method of its manipulation. 2500 w. Jour Gas Lgt—Nov. 22, 1898. No. 24455 A.

Volumetric Analysis.

The Estimation of Hydrogen, Marsh Gas

and Nitrogen in Mixtures of Gases. E. Jäger. Abstract translation from the *Journal für Gasbeleuchtung*. Describes a fractional combustion method which has given satisfactory results. 2000 w. Jour Gas Lgt—Dec. 13, 1898. No. 24673 A.

Water Gas.

Theory of the Water Gas Process. H. Luggin. Translated from the *Journal für Gasbeleuchtung und Wasserversorgung*. Reviews the theory of Hoitsema, and the results of his experiments brought forward in support of his theory, making application of the theory to the water gas process. 3000 w. Pro Age—Dec. 15, 1898. No. 24625.

SEWERAGE.

Catch-Basins.

Cleaning Catch-Basins, Yonkers, N. Y. Illustrated description of a simple apparatus resulting in a decrease in the cost of cleaning. 500 w. Eng Rec—Dec. 17, 1898. No. 24601.

Sewage.

Bacterial Treatment of Sewage. Editorial discussion of the systems at Exeter and Sutton, Eng., and the views presented by Messrs. Thudicum and Latham. 2000 w. Engng—Dec. 9, 1898. No. 24639 A.

Sewage Works.

The Chorley Sewage Works. Illustrates and describes an intermittent system of purification. 1700 w. Can Engr—Dec., 1898. No. 24551.

Sewers.

The Construction and Ventilation of Sewers. W. Gruggen. Considers the requirements of a properly designed sewer. 2000 w. San Rec—Dec. 16, 1898. No. 24790 A.

STREETS AND PAVEMENTS.

Asphalt.

Theory and Practice of Asphalt Mixtures. A. W. Dow. An explanation of the phenomena met with in asphalt construction, and the importance of selecting the proper sand. 2000 w. Munic Engng—Dec., 1898. No. 24375 C.

Contracts.

The Ethics of Certain Chicago Paving Contracts. Reviews a decision of the Supreme Court of Illinois concerning a contract between an asphalt company and lobbyists employed to promote its interests. 2300 w. Eng Rec—Dec. 17, 1898. No. 24596.

Paving.

A Study of Paving Materials. Edward P. North. Reviews the advantages of different materials. 700 w. Eng Rec—Dec. 3, 1898. No. 24360.

Bituminous Rock Paving in San Francisco, California. Information concerning this material and its use. It is being used to pave Market St., the principal thoroughfare of San Francisco. 1500 w. Eng News—Dec. 22, 1898. No. 24677.

WATER SUPPLY.

Cincinnati, Ohio.

Progress on the New Water-Works for Cincinnati, O. Illustrated description of the comprehensive improvements in progress for which $6,500,000 of bonds have been authorized. 3300 w. Eng News—Dec. 8, 1898. No. 24496.

Filtration.

A New Covered Filter Bed for the Water-Works of Somersworth, N. H. Drawings and description of a slow sand filtration plant covered with a masonry roof. 1600 w. Eng News—Dec. 8, 1898. No. 24498.

The Louisville Experiments with Mechanical Filtration. Gives the leading results of two years' experiments with different methods of purifying a silt-bearing river water. 2400 w. Eng Rec—Dec. 3, 1898. No. 24358.

Hungary.

The Water Supply System of Faesz. (Die Wasserversorgungs-Anlage der Gemeinde Faesz.) An illustrated account of a small water supply and sewerage plant at Faesz near Veszprem, in Hungary. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Dec. 2, 1898. No. 24812 B.

London Supply.

Water Supply from the Chalk. A discussion of the London County Council's Scheme and the opposition to it, and the capability of the chalk as a source of supply. 3500 w. Builder—Dec. 17, 1898. Serial. 1st part. No. 24777 A.

Main Bursting.

The Bursting of a Water-Main in Brooklyn. An account of the great damage caused by the bursting of a 48 inch main. 700 w. Sci Am—Dec. 24, 1898. No. 24703.

Paris.

The Water Supply in Paris. An account of the projects for bringing fresh supplies of water to the city, and the distribution 2300 w. Engr, Lond—Dec. 16, 1898. No. 24740 A.

Pipe.

Wooden Stave Pipe vs. Riveted Pipe. D. C. Henny. A comparison of the two classes of pipe mentioned, especially setting forth the merits of stave pipe. Discussion. 7600 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24713 C.

Pollution.

The Ashland Water Pollution Case. Review of the decision of the Wisconsin Supreme Court of the liability of a water-company for the quality of water it supplied. 2000 w. Eng Rec—Dec. 24, 1898. No. 24727.

Porto Rico.

The Water-Works of San Juan. William Dinwiddie. A brief description of the works approaching completion which it is hoped will furnish the much needed pure water. 1000 w. Harper's Wk—Dec. 24, 1898. No. 24684.

Purifying.

The Purifying and Sterilizing of Water by Ozone. Translated from *La Vie Scientifique*. Describes the system employed by Mr. Tindal at the municipal works of Saint Maur. Ill. 800 w. Elec, N. Y.—Dec. 28, 1898. No. 24924.

Reservoir.

Construction of a Water-Works Reservoir in Madrid. (Construcción de un Tercer Depósito de Aguas en Madrid.) An illustrated account of the construction of a cellular covered reservoir, 356 by 216 metres in size, in Madrid. It is built of brick and Portland cement and the roof rests on steel beams supported by brick pillars. Its total capacity is 471,520 cubic metres. 2400 w. Revista de Obras Publicas—Nov. 10, 1898. No. 24849 D.

Rochester, N. Y.

Rochester and Its Water-Works. Extracts from the annual report of Chief Engineer Kinchling. 2800 w. Fire & Water—Dec. 17, 1898. No. 24652.

Town Supply.

Town Water-Works from a Financial Standpoint. W. L. Hedenburg. Shows that a town need not necessarily lay out a large sum of money in a pumping plant, nor pay a heavy tax for operating expenses. 2000 w. Munic Engng—Dec., 1898. No. 24374 C.

Tunnel.

The Cleveland Water-Works Tunnel. A progress report on the construction of a tunnel which has already had two fatal gas explosions. 1000 w. Eng Rec—Dec. 17, 1898. No. 24600.

Water Main.

A 61-Inch Cast-Iron Pipe Line. Describes a 61-in. main of pipes 1¼ ins. thick, on which numerous important experiments on the strength of such castings were made. 1700 w. Eng Rec—Dec. 17, 1898. No. 24599.

Water Works.

Improvements of the Water-Works of Council Grove, Kan. L. L. Tribus. Describes improvements to a river supply in an alluvial region, with fairly satisfactory results. Ill. 1500 w. Eng News—Dec. 15, 1898. No. 24587.

Wells.

The Yield of Wells and Collecting Galleries in Permeable Soils. James H. Fuertes. Illustrated article combining the theories of Smreker, Oestern, Lueger, Thévenet, Kroeber, Soyka, Mancini, Frühling and others in formulas agreeing with experiments. 3200 w. Eng Rec—Dec. 10, 1898. No. 24540.

MISCELLANY.

Boundaries.

State, City and Town Boundaries. Henry B. Wood. Reviews the history of boundaries in Massachusetts and contemplated work in this field. 8000 w. Jour Assn of Engng Soc's—Nov., 1898. No. 24712 C.

Cheap Dwellings.

Cheap Dwellings. (Les Logements à Bon Marché.) A general discussion of the question of cheap and sanitary dwellings for laborers and the poorer classes. 2500 w. La Revue Technique—Nov. 25, 1898. No. 24856 D.

City Charter.

A Model City Charter; the Report of a Committee of the National Municipal League. Editorial presentation of the main features of the work accomplished by the committee appointed by the National Municipal League to report on a program embodying essential principles of municipal government, &c. 3000 w. Eng News—Dec. 1, 1898. No. 24327.

Refuse Destructors.

Combined Destructor and Electric Light Plants. Ernest Kilburn Scott. Calls attention to some points worth considering before deciding to utilize destructor heat for electric-lighting purposes. 1200 w. Elec Rev, Lond—Dec. 9, 1898. No. 24633 A.

Sanitation.

Theatre Sanitation. William Paul Gerhard. Read at meeting of the Am. Pub. Health Assn., at Ottawa, Can. A paper on the hygiene of theatres, considering drainage, plumbing, water supply, ventilation and general sanitation. 5500 w. San—Dec., 1898. No. 24417 D.

The Relative Importance of Flies and Water Supply in Spreading Disease. Dr. M. A. Veeder. Abstract of paper read at meeting of the Buffalo Sanitary Club. A discussion of dangers from these sources, and means of prevention. 2500 w. Eng News—Dec. 22, 1898. No. 24676.

The Scientific Prevention of Yellow Fever. Alvah H. Doty. Considers the cause of this disease, the manner in which it is propagated, the means of overcoming the conditions, &c., with remarks on the need of a national health bureau. 6800 w. N Am Rev—Dec., 1898. No. 24386 D.

RAILWAY AFFAIRS.

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in October. Detailed list with classified summary and remarks. 3500 w. R R Gaz—Dec. 2, 1898. No. 24405.

Character.

Conduct and Character. M. N. Forney. A lecture to railroad and supply men on this subject. 14800 w. N Y R R Club—Nov. 17, 1898. No. 24579.

Cost of Hauling.

The Comparative Costs of Highway Haulage. (Sue Confronto Economico dei Tracciati Stradali.) D. Ruggeri. A rather elaborate study of methods of comparing costs of haulage on different roads and of calculating approximate costs for moving freights on highways in contemplation, with the bearing of these costs on the design of such roads. Serial. 1st part. 5000 w. Annali d Soc d Ing e d Archit Ital—Sept-Oct., 1898. No. 24872 E.

Russian Railroads.

Russian Fares and Trains and the Siberian Railroad. Information of interest concerning the transportation system, and probable cost, at present rates, of a journey from London to China. 2000 w. R R Gaz—Dec. 23, 1898. No. 24720.

Snow.

The November Snow Storm on Long Island. An illustrated account of the struggle against the recent heavy snow on the railroads, especially on Long Island. 600 w. R R Gaz—Dec. 16, 1898. No. 24591.

Weak Bridges.

Is it Safer to Run Fast or Slow Over a Weak Bridge? A communication from an engineer advocating running fast and giving reasons. 1400 w. Eng News—Dec. 8, 1898. No. 24497.

FINANCIAL.

Railway Incomes.

Railways and Prosperity. Extract from the report on the railways of Pennsylvania for the year ending June 30, 1898, prepared by Isaac B. Brown, superintendent of the Bureau of Railways. 3600 w. Ry Age—Dec. 16, 1898. No. 24667.

Supplies.

The Purchase and Inspection of Railway Supplies. Editorial discussion of paper by H. B. Hodges, read at the Oct. meeting of the N. Y. R. R. Club. 800 w. Ry Mas Mech—Dec., 1898. No. 24394.

LEGAL MATTERS.

Anti-Scalper Law.

New York Anti-Scalper Law Dead. The opinion rendered by the New York Court of Appeals, with editorial. 4500 w. R R Gaz—Dec. 2, 1898. No. 24404.

Anti-Trust Act.

The Scope and Effect of the Anti-Trust Act. From the *Yale Review*. A brief review of railroad history in this connection and a discussion of the legislation on this subject in the United States, as compared with England. 1200 w. R R Gaz—Dec. 9, 1898. No. 24488.

Cotton Tariff.

The Decision in the Texas Commission Cases. Decision rendered by Judge A. P. McCormick. A complete victory for the railroads. 2800 w. Ry Age—Dec 9, 1898 No. 24546.

Interstate Commerce.

The Powers of the Interstate Commerce Commission. Basil W. Duke. A discussion of the views advanced by Charles A. Prouty, in the November number of the *N. Am. Review*. 4300 w. R R Gaz—Dec. 16, 1898. Serial. 1st part. No. 24593.

MOTIVE POWER AND EQUIPMENT.

Bolsters.

The Computation of the Deflection of Body and Truck Bolsters. William Kendrick Hatt. Derives a formula for the case of uniform loading and for end loading. Also gives a description of a graphical process for drawing the curve into which the bolster will bend under any loading, from which curve the deflection at any point may be obtained. 2000 w. R R Gaz—Dec. 23, 1898. No. 24717.

Car Locks.

Continuous Safety Lock System for Railway Cars. (Chiusura Continua di Sicurezza per i Veicoli Ferroviari.) G. Kaiser. Describes a method for locking all the doors of a train of compartment cars by a compressed air system operated from the locomotive or from each car and automatically unlocking in case of accident. 1000 w. 1 plate. Annali d Soc d Ing e d Archit Ital—Sept.-Oct., 1898. No. 24873 E.

Cylinders.

Locomotive Cylinder Proportions. G. R. Henderson. A discussion of this subject, giving the opinion that the weight on drivers should be proportioned to maximum rates of grades, while the steam-making capacity should be proportioned to the average resistance and schedule speed. 3200 w. Am Eng & R R Jour—Dec., 1898. No. 24379 C.

Dump Car.

A Sectional Dump Car. Illustrates and describes the Page car, which consists of a series of dumping boxes mounted on the car frame. 1000 w. Eng News—Dec. 22, 1898. No. 24678.

Framing.

The Framing of Cars. F. M. Whyte. Extract from paper read before the Western Railway Club, with editorial comment. Suggestions for improvements in the distribution of loads. 3000 w. Ry & Engng Rev—Dec. 24, 1898. No. 24774.

Locomotives.

Compound Freight Locomotives for the Paris-Lyons-Mediterranean Rwy. (Locomotives Compound à Marchandises de la Cie. P.-L.-M.) Description of a four-coupled compound, illustrated by elevations. The high pressure cylinders are outside, while the low-pressure cylinders are mounted close together inside the frame and operate cranks on the second axle. 1200 w. Le Génie Civil—Nov. 19, 1898. No. 24863 D.

Mogul Locomotives for the Delaware, Lackawanna & Western. General specifications with illustration. 200 w. R R Gaz—Dec. 2, 1898. No. 24406.

Narrow-Gauge Locomotive for the Cauca Railway. Illustrated description of an engine for a South American road, built at the Baldwin Locomotive Works. 1000 w. Am Eng & R R Jour—Dec., 1898. No. 24381 C.

New Express Engines on the Great Eastern Railway. Charles Rous-Marten. Records results attained during several experimental journeys with these engines. 1800 w. Engr, Lond—Dec. 2, 1898. No. 24528 A.

High Speed Locomotive. (Note sur une Locomotive à grande Vitesse.) Ch. Corteil. This locomotive was built to haul 250 ton trains on level roads at a speed of 50 miles per hour. Its principal peculiarity was in the use of a fire box of refractory bricks. 1800 w. 1 plate. Rev

Univ des Mines—Nov. 1898. No. 24877.

Recent Brooks Locomotives—B. R. & G. Ry. and O. R. & N. Co. Illustrated description and interesting comparison of freight engines built for a far western road with those built for an eastern road. 1200 w. Ry & Engng Rev—Dec. 10, 1898. No. 24566.

Some Recent Rogers Locomotives. Principal specifications, with illustration, of 10 wheel freight locomotives for the Illinois Central R. R. 500 w. R R Gaz—Dec. 2, 1898. No. 24403.

The Evolution of the Locomotive Engine. William P. Marshall. From a paper read before the Inst. of Civ. Engs., London. A record of the leading steps in the evolution of the present locomotive, with notice of further steps now in process of trial. 2300 w. R R Gaz—Dec. 2, 1898. No. 24402.

The Present Status of the Compound Locomotive. Reviews the opinions of railroad officers with regard to the value of this type, showing the wide differences and concluding that with light loads there is nothing to be gained by compounding. 1400 w. Am Eng & R R Jour—Dec., 1898. No. 24382 C.

Private Train.

The Private Train of the Emperor of Germany. Illustrated detailed description. 2500 w. R R Car Jour—Dec., 1898. No. 24509.

Smoke.

Burning Soft Coal without Smoke. Angus Sinclair. Describes the practice on the Burlington, Cedar Rapids & Northern Railway which secured smokeless locomotive firing, and greatly lessened the fuel expense. Ill. 5000 w. Loc Engng—Dec., 1898. No. 24397 C.

Smoke Boxes.

Short Smoke Boxes for Locomotives. Discussion of the present tendency in design, stating the advantages of short fronts, and describing the arrangements devised by different makers. Ill. 2200 w. Am Eng & R R Jour—Dec., 1898. No. 24380 C.

NEW PROJECTS.

China.

Foreign Possessions in China, and their Prospective Railways (Die Fremden Besitzungen in China und deren Künftigen Eisenbahnen.) H. Post. A discussion by the Austrian consular attaché at Shanghai, of the probable development of Chinese railways consequent upon political changes. 1800 w. Zeitschr d Oesterr Ing u Arch Ver—Nov. 18, 1898. No. 24811 B.

Indian Railway.

Nilgiri Railway. Part first discusses gradients and curves, stations, tunnels, ballast, brakes, &c. 2000 w. Ind Engng—Nov. 12, 1898. Serial. 1st part. No. 24636 D.

Madagascar.

Railway Contract in Madagascar. A copy of a concession for a railway from Tananarivo to Tamatave. 2800 w. U. S. Cons Repts—Dec., 1898. No. 24519 D.

Railway Extensions.

City and South London Railway Extensions. Illustrates and describes the interesting operations in connection with this work. 1400 w. Elec Rev, Lond—Dec. 16, 1898. No. 24784 A.

Siberia.

See Economics and Industry, Commerce and Trade.

Trans-Saharan Railway.

The Trans-Saharan Railway (Le Chemin de Fer Transsaharien.) Account of a proposed railway across the Sahara desert which will be of great strategic value to the French colonies in Africa. It is proposed to prolong the Sfax-Gafsa line across the desert to Lake Tchad, about 2000 kilometers. 1200 w. Moniteur Industriel—Oct. 15, 1898. No. 24888 E.

PERMANENT WAY, BUILDING AND FIXTURES.

Block System.

The Block System on the Atchison. Details of the regulations under which trains are run, with facts of interest concerning the apparatus. Ill. 1200 w. R R Gaz—Dec. 23, 1898. No. 24718.

Concrete Structures.

Concrete Railway Structures. F. G. Jonah. Read before the Canadian Soc. of Civ. Engs.—Dec. 8, 1898. Illustrates and describes designs of concrete culverts and bridge piers. 800 w. Adv Proof. No. 24582.

Interlocking.

Interlocking at Greensburg, Ind. Illustrated description of a plant especially interesting because of the arrangement of the levers. 1200 w. R R Gaz—Dec. 9, 1898. No. 24485.

Joints.

The Construction of Rail Joints. (Ueber Stossfugen-Ueberbruckung.) A paper by Dr. Vietor before the German Railway Society, discussing the action of shock upon rail joints, and the best methods of diminishing injurious action. 4000 w. Glaser's Annalen—Dec. 1, 1898. No. 24819 D.

Kobe Workshops.

The Workshops of the Japanese Imperial Railways at Kobe. Notes relating to these shops, with general remarks. 1200 w. Engr, Lond—Nov. 25, 1898. No. 24433 A.

Midland Railway.

The Midland Railway in London. Illustrated description of the Kentish Town widening and Somers Town coal depot, reconstruction of stations, &c. 2800 w. Transport—Nov. 18, 1898. No. 24314 A.

Railway Extension.

Great Northern and Strand Railway. Describes the extension of this system into the center of London. Map. 1400 w. Transport—Nov. 25, 1898. No. 24449 A.

Safety.

The Evolution of Safety in Railway Travel. Charles Hansel. This interesting paper traces the development of safety appliances for railways from the beginning. It treats of methods

of switching and signalling, interlocking devices, the protection of road grade-crossings and the crossings of steam and electric railways. The mechanism of signal cabins is fully described and illustrated, other illustrations also showing signals protecting stations and drawbridges. 4100 w. Engineering Magazine—Jan., 1899. No. 24897 B.

Sleepers.

The Hasselmann Process for Treating Railway Sleepers. (Ueber die Tränkung der Eisenbahnschwellen nach Hasselmanns Verfahren.) The process consists in forcing into the pores of the wood a solution consisting of a mixture of sulphate of alumina and sulphate of iron and copper. 1800 w. Oesterr Monatschr f d Oeffent Baudienst—Dec., 1898. No. 24816 D.

Station.

New Passenger Station at Albany, N. Y. Brief description with illustrations of the plans decided upon for a station to accommodate the N. Y. C. & H. R. R. R., the B. & A., and the D. & H. railroads. 400 w. R R Gaz—Dec. 16, 1898. No. 24592.

Steel Rail.

Life of Steel Rails in Italy. Observations on the wear of steel rails on the various lines of the Adriatic Railway of Italy. 900 w. Ry & Engng Rev—Dec. 10, 1898. No. 24568.

Terminal.

The New Terminal Station of the Orleans Rwy. Co. (La Nouvelle Gare Terminus de la Compagnie d'Orleans.) Alfred Boudon. An illustrated description of the condition of the work at the Quai d'Orsay (Paris) with numerous plans of buildings, etc. 3500 w. Le Génie Civil—Nov. 19, 1898. No. 24861 D.

Track Tanks.

The Use of Track Tanks. Editorial on the limited use and the reasons why they are not usually profitable. 1300 w. R R Gaz—Dec. 9, 1898. No. 24489.

Water Station.

Submerged Water Station N. P. Ry. Illustrates and describes a system of water supply, invented by E. H. McHenry, in which a submerged tank is used for storage, and steam from the locomotive used to force the water into the tender tank. 800 w. Ry & Engng Rev—Dec. 17, 1898. No. 24659.

TRAFFIC.

Express Charges.

An Attack upon Railways Through the Express Companies. Editorial discussion of the schedule of charges prepared by the Merchants' Association of New York, and the statements made. 1400 w. Ry & Engng Rev—Dec. 24, 1898. No. 24775.

Pooling.

The Decision Against Railway Pooling. Roswell Miller. Thinks the only remedy for the existing state of things, is to permit agreements among roads as to rates, and to permit pooling. 1000 w. N Am Rev—Dec., 1898. No. 24388 D.

STREET AND ELECTRIC TRAMWAYS.

Accounts.

Theory of Reserve and Suspense Accounts. A. O. Kittredge. A discussion showing the necessity of these accounts and illustrating by example. Also considers the objections usually urged. 2500 w. St Ry Jour—Dec., 1898. No. 24413 D.

American Traction.

A French View of American Electric Traction. Extracts from French journals taken from notes of French engineers sent to study American methods. 1300 w. Elec Rev, Lond—Nov. 25, 1898. No. 24443 A.

Braking.

The Braking Action of Induction Motors (Ueber die Bremsung von Induktions Motoren.) Friedrich Eichberg. A mathematical discussion of the various methods by which the braking action of induction motors may be effected with especial reference to use for tramway service. 5000 w. Elektrotech Zeitschr—Nov. 24, 1898. No. 24837 B.

Capital Traction Co.

The Open-Conduit System of the Capital Traction Company. Illustrates and describes the reconstruction of the tracks, the power-house, coal-conveying apparatus, boilers, flues and stack, steam and water piping, engine room, &c., with editorial. 6500 w. Elec Wld—Dec. 31, 1898. No. 24920.

Conduit Construction.

Conduit Construction of the Third Avenue Railway Company, New York. The work of changing from the cable to the electric system is described; also the horse lines that are to be equipped electrically, and other improvements in rolling stock, &c., to be made by this line. 2500 w. St Ry Jour—Dec, 1898. No. 24412 D.

The New Bastille-Charenton Line of Electric Tramways. (La Nouvelle Ligne de Tramways Electrique Bastille-Charenton.) J. Prouteau. A well illustrated description of this line, the first overhead trolley railway in Paris, with special reference to the construction of the conduit section. 4000 w. La Revue Technique—Nov. 25, 1898. No. 24856 D.

Construction Work.

Roadbed Over a Sewer. Illustrates and briefly describes a piece of ingenious work found necessary in laying the electric conduit in Canal St., New York. 350 w. St Ry Rev—Dec. 15, 1898. No. 24723 C.

Egypt.

Electric St. Railroads in Cairo, Egypt. Brief illustrated description of the rapid-transit system inaugurated August, 1896. 700 w. Elec Wld—Dec. 31, 1898. No. 24921.

Electric Railroads.

The Coming Electric Railroad. Sidney H. Short. A discussion of the chief points in effec-

ting a change from steam to electricity on trunk lines. Ill. 4000 w. Cos—Jan., 1899. No. 24662.

Electric Traction.

Conduit v. Trolley. A brief description of the excellent design of center poles and other equipment used on the Bastille-Charenton Line, Paris, with comparison of the first cost in conduit and trolley lines. 1200 w. Elec Rev, Lond—Dec. 9, 1898. No. 24631 A.

Electrolysis.

Some Fallacies Regarding Electrolysis. Albert B. Herrick. Considers the conditions necessary for its existence in railway systems, methods of locating the paths of destructive currents, the methods of prevention, &c. Ill. 4400 w. St Ry Jour—Dec., 1898. No. 24411 D.

Elevated Railroad.

Chicago Metropolitan West Side Elevated Electric Railroad. Briefly describes the plan of the lines, the power-house and its equipment, track construction, &c., giving illustrations. 1500 w. Elect'n, Lond—Nov. 18, 1898. No. 24318 A.

Some Elevated Railway Problems and Results. Considers the conditions confronting the "station class" of railways, especially discussing the elevated systems in New York and Chicago. Ill. 4500 w. St Ry Jour—Dec., 1898. No. 24407 D.

The Multiple Unit System on the South Side Elevated Railway of Chicago. Discusses the Sprague system, its interesting features and appliances, stating its advantages. Ill. 2800 w. St Ry Jour—Dec., 1898. No. 24408 D.

The Union Elevated Railway of Chicago. Illustrated description of the "Loop" property in Chicago, and its working. 2000 w. St Ry Jour—Dec., 1898. No. 24409 D.

Interurban.

The Interurban Railway Between Anderson and Marion, Ind. Illustrates and describes the road and its equipment. 1200 w. St Ry Jour—Dec., 1898. No. 24410 D.

Mileage.

Railway Mileage in Foreign and American Cities. From the *Surveyor*, of London. Gives figures upon the cost of operating trolley lines, and table giving the miles of track and population per mile. 800 w. St Ry Rev—Dec. 15, 1898. No. 24722 C.

Paris Metropolitan.

The Metropolitan (Railway) in Paris. (Le Métropolitain de Paris.) Georges Leugny. An illustrated description, with map, of this important undertaking, giving also historical data, particulars of tunnels, stations, costs, methods of work, etc. 4000 w. La Revue Technique—Dec. 10, 1898. No. 24854 D.

Power Station.

The Harvard Power Station of the Boston Elevated Railway Company. H. W. Weller. Brief review of street-railway history in Boston, with illustrated detailed description of the Harvard Power Station and its equipment. 3500 w. Ry Wld—Dec. 8, 1898. No. 24900 A.

Union Elevated Railroad Power House, Chicago. Illustrated detailed description of this recently completed station. 1800 w. Elec Eng, N. Y.—Dec. 15, 1898. No. 24571.

Street Railways.

Practical Points in Street Railway Engineering. W. A. Harding. Read before the Chicago Elec. Assn. Some points on the selection of cars, motors, etc., for suburban roads. 1200 w. Elec Rev, N. Y.—Dec. 14, 1898. No. 24564.

Surface Contact.

Surface Contact Electric Railways. Edward H. Johnson. Read before the New York Elec. Soc. Discusses the causes that have retarded the development of this idea, and notes briefly the salient features of the most ambitious efforts in this field. Ill. 4700 w. Elec. N. Y.—Nov. 30, 1898. No. 24305.

Thompson-Walker System.

The Thompson-Walker System of Electric Traction. A brief illustrated sketch of this system taken from a pamphlet published by the inventors. 1100 w. Elec, Lond—Dec. 9, 1898. No. 24626 A.

Ties.

The Preservation of Ties. W. H. Glenn. Recommends treating the ties with creosote, and gives suggestions relating to the plant. 1800 w. St Ry Rev—Dec. 15, 1898. No. 24724 C.

Tramways.

Conduit vs. the Trolley System. Report of Mr. John Young to the Glasgow Tramways Committee on the advisability of introducing the conduit system. 3500 w. Ry Wld—Dec. 8, 1898. No. 24904 A.

Liverpool Corporation Electric Tramways. An illustrated description of the portion of the line opened for traffic. 2500 w. Elec Rev, Lond—Nov. 18, 1898. No. 24316 A.

Street Railways of Meadville, Pa. Information relating to the electric lines of this city and the traffic. Ill. 1000 w. St Ry Rev—Dec. 15, 1898. No. 24721 C.

The Lausanne Electric Tramways. C. Du Riche Preller. Illustrates and describes a system especially interesting because of its exceptionally steep grades. 5000 w. Engng—Dec. 16, 1898. No. 24744 A.

The Tramways of Blackpool and Neighborhood. Notes taken on a recent visit on the working of the three systems operated in this vicinity. 2000 w. Ry Wld—Dec. 8, 1898. No. 24902 A.

Vienna Tramways. An account of provisions for a comprehensive system of electric traction. 1400 w. Ry Wld—Dec. 8, 1898. No. 24903 A.

Trucks.

A Test of the Peckham Truck. This company having the contract to furnish trucks for the South Side Elevated in Chicago, a special test to demonstrate the strength was made, and is described. Ill. 700 w. R R Gaz—Nov. 25, 1898. No. 24210.

Vienna.

Electric Traction in Vienna. Brief description of combined trolley and accumulator lines, with engravings of rail and car. 900 w. Ry Wld—Nov. 10, 1898. No. 24045 A.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them. Please mention The Engineering Magazine when you write.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.=Handsomely illustrated catalogue (*a*) describing the forge shops in a number of American schools of mechanical technology in which Buffalo forge equipments are used; (*b*) showing various forms of Buffalo automatic steam engines.

Jeffrey Mfg., Co., Columbus, Ohio, U. S. A.= Catalogues (*a*) of chain belting and steel cable elevating and conveying machinery; (*b*) special price list of elevator buckets and spiral conveyors; (*c*) Jeffrey electric locomotives for mine haulage.

Cincinnati Milling Machine Company, Cincinnati, Ohio, U. S. A.=Illustrated catalogue of improved universal cutter and tool grinder, with photographic reproductions showing the great variety of work of which the machine is capable.

Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., U. S. A.=Illustrated catalogue descriptive of the modern round house turntable, showing the Westinghouse turntable "donkey" as applied to existing turntables.

Westinghouse, Church, Kerr & Co., New York.=Small, well printed pamphlet giving a bird's eye view of the general business of the firm, with numerous illustrations of Westinghouse steam and gas engines.

General Electric Company, Schenectady, N.Y., U.S.A.=Handsomely printed catalogues (*a*) describing and illustrating Thomson recording watt meters for various kinds of service, with diagrams showing connections, together with useful information regarding electric meters; (*b*) catalogue describing transformer design and operation, including papers by W. J. White and W. E. Goldsborough.

Lidgerwood Mfg. Co., New York.=Publications as follows: (*a*) general catalogue of hoisting engines, cableways, log hauling machinery, hoisting and conveying apparatus, and Tremperley transporters; (*b*) illustrated catalogue of devices for logging by steam; (*c*) advance proofs of Lidgerwood safety derrick engine; (*d*) pamphlet showing contractor's methods employed on the Chicago drainage canal; (*e*) catalogue of the Lidgerwood rapid unloader; (*f*) catalogue of the Tremperley transporter and Lidgerwood transfer.

Baldwin Locomotive Works, Philadelphia, Pa., U.S.A.=Record of recent construction for December, 1898, giving illustrations and specifications of simple and compound locomotives built for various railways in the United States, Mexico, New Zealand, Finland, and China.

Chester B. Albree, Allegheny, Pa., U. S. A.= Catalogue of ornamental and structural iron work, bridge railings, stairways, portals, etc., also pneumatic riveting machines.

Lombard Water-Wheel Governor Company, Boston, Mass., U. S. A.=Catalogue B, descriptive of various forms of water-wheel governors, with instructions as to data for estimating, and testimonials from users.

Hilles & Jones Company, Wilmington, Del., U. S. A.=Catalogue P, of machine tools for working plates, sheets, bars, and structural shapes, with many illustrations of powerful machines for punching, shearing, bending, and riveting, arranged to be driven by belting, steam, or electric power.

E. W. Bliss Company, Brooklyn, New York, U. S. A.=Handsome album of views of various interiors in the establishment of the E. W. Bliss Company, showing the extent of the works and character of the equipment.

Rumsey & Co., Limited, Seneca Falls, N. Y., U. S. A.=Pamphlet catalogue of triplex power pumps, adapted for a variety of heads and pressures, and arranged to be driven by belt or electric motor.

The American Fireproofing Co., Boston, Mass., U. S. A.=Catalogue describing Merrill's Salamander fire-proof composition for buildings, with examples of its application, and testimonials from users.

The Deane Steam Pump Company, Holyoke, Mass., U. S. A.=General catalogue of Deane steam and power pumps and pumping machinery for every variety of service. Details of dimensions, speeds, capacities and pipe sizes are given, with telegraph code words, and numerous tables of useful information.

Denver Engineering Works, Denver, Colorado, U. S. A.=Catalogue of steam and electric hoisting plants especially adapted for mining service, also hoisting rope of steel wire, and general accessories for mine hoisting plants.

The Bedford Engineering Co., Bedford, England.=Price-list of steam cranes. Illustrated.

Lake & Elliot, Albion Works, Braintree, England.=Illustrated price-list of tools for cycle makers and repairers.

Robert Boby, Ltd., Bury St. Edmunds, England.=(*a*) Catalogue of grain, malt, and seed cleaning machinery. Fully coded, illustrated, and priced. (*b*) Condensed price-list of above machinery.

Chas. Taylor, Bartholomew street, Birmingham, England.=Illustrated catalogue of lathes and tools for grinding; also of milling machines, vices, and engineer's hand tools. Good descriptions, prices being given in each case.

Graham & Fleming, Premier Works, Halifax,

England.=Catalogue of wrought-iron and steel, welded and riveted boilers for domestic use; also of valves, cisterns, furnace fronts and copper boilers. Sectional illustrations and tables of sizes, prices, and heating powers expressed in terms of 4 inch pipe are given in each case. Stiff cover.

E. & J. Richardson, Elswick Leather Works, Newcastle-on-Tyne, England.=Price list of leather belting, with useful tables of horse power transmitted by various sizes. Folder style.

Holden & Brooke, Ltd., Manchester, England.=8 page catalogue of Brooke's "Anti-primer" steam dryer and purifier with description, prices, and drawings; showing application to various types of engines.

W. E. Kenway, Burlington Chambers, New St., Birmingham, England.=Pamphlet describing Kenway's electric traction system with illustrations; also brief account of the "Victor" rail joint.

Thomas Summerson & Sons, Darlington, England.=Handsome cloth volume entitled "A Handy Platelayer's Guide," containing useful tables and diagrams of switches and crossings. The book covers 90 pages, of which the first thirty are devoted to general information on permanent way, the remainder to tables and diagrams.

E. D. Reeve, 60 High street, Wandsworth, London.=Catalogue of laundry machinery giving wood cut views of various types of machines and information about Reeve's combined washing machine, hydro-extractor, and tumbler. Paper cover.

Woods & Co., Suffolk Iron Works, Stowmarket, England.=Illustrated price lists; (*a*) of grinding mills, malt crushers, oil cake breakers, shedders, etc. 28 pages of condensed information; (*b*) of field implements such as rolls, harrows, sheep hurdles, water carts, etc. An illustration of each machine is given. Paper cover.

Darlington & Co., Llangollen, Wales.=Preliminary circular relative to Darlington's handbooks.

Blackstone and Co., Ltd., Stamford, England.=(*a*) Price list of hay harvesting machines, including rakes and mowing machines, with full description of each type; (*b*) Circular giving sizes, prices and testimonials of the Blackstone oil engine.

Mackies, Ltd., Berks Iron Works, Reading, England.=Illustrated catalogue of pulleys, gearing, pedestals, and general millwright work; also of wrought iron gates, and wheelbarrows. Stiff paper cover.

W. & T. Avery, Ltd., Soho Foundry, Birmingham, England.=Illustrated catalogue of weighing apparatus, in three sections, dealing respectively with weighbridges, platform weighing machines, and miscellaneous machines, such as wire testers, hot rail weighers, etc.

C. J. Edwards & Son, Ltd., 32 Great Sutton street, London, E. C.=Illustrated price-lists (*a*) of shafting plummer blocks, cast iron and wood pulleys hangers, and other shafting appliances; (*b*) of leather belting and engineers' sundries, such as oil cans, lubricators, belt-fasteners, etc.

E. S. Hindley, Bourton, Dorset, England.=Price-list of vertical and horizontal steam engines and boilers, saw benches and pumps, with weights, measurements, powers, and quantities. Fully illustrated. 48 pp.

Bickford Smith & Co., Ltd., Tucking Mill, Cornwall, England.=Descriptive and illustrated price-list of safety and instantaneous fuses for blasting. Twenty-seven types of fuses are enumerated; the catalogue contains many useful facts about blasting. Cloth cover. 67 pp.

D. H. Bonneller & Son, 58 Mortimer street, London, W.=Illustrated price-lists (*a*) of electric bells and accessories; (*b*) of incandescent lamps.

Spencer & Co., Ltd., Melksham, Wilts, England.=Hand-book of illustrations from photographs of work carried out for mechanical handling of grain, seed, coal, etc., with brief descriptions.

W. H. Willcox & Co., 34 Southwark street, London, S. E.=Price-list of a great variety of oils, engineers' hand tools, valves, gauges, pulleys, and mill and railway furnishings. Complete index. 191 pp.

F. Barker & Son, 12 Clerkenwell road, London, England.=Trade catalogue of pocket and ship compasses, barometers, and a variety of scientific and surveying instruments. Prices invariably given. 100 pp.

Woodite and Whaleite Works, Mitcham Common, Surrey, England.=Price-list of woodite and whaleite goods as used for packing, mats, shoe soles, corks, washers, hose, etc.

The Reeves Patent Filters Co., Ltd., 39 Victoria street, Westminster, London, E. C.=Circulars illustrating, describing, and giving list of users of (*a*) The Reeves patent feed-water filter; (*b*) the Destrumaux automatic water softeners; (*c*) The Reeves gravity filter.

Bryan Donkin & Co., Ltd., Southwark Park road, Bermondsey, London.=(*a*) Catalogue of exhausting plant for gas-making, with list of users; also of hydraulic regulators, fully illustrated. Detailed descriptions; (*b*) price-list of valves for gas, chemical, and other uses; (*c*) six circulars dealing with Fleron & Andersen's stop valve, steam engines, blast fans, air propellers, oil engines, and exhaust steam valves.

W. T. Glover & Co., Ltd., 39 Victoria street, London, S. W.=Catalogue of electric light wire and cable, with finger index, containing dimensions, capacity, resistance, weight, and other particulars.

Thos. Barraclough, 20 Bucklersbury, London, E. C.=Illustrated price-lists: (*a*) Wire strand and wire rope machinery; (*b*) hemp rope machinery. Both lists are well illustrated, and contain considerable technical information.

Clayton, Howlett & Co., Atlas Works, Woodfield road, Harrow road, London.=Illustrated catalogue of brick-making machinery, plastic and semi-dry, presses, tile and pipe machinery; also listing portable railways, grinding mills, and engines. 54 pp. Paper cover.